TMENT OF TECHNOLOGY
BUFFALO PUBLIC LIBRARY

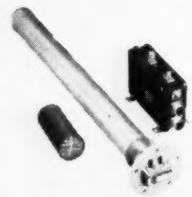
AERONAUTICAL ENGINEERING REVIEW

INSTITUTE OF THE AERONAUTICAL SCIENCES

FEBRUARY 1953

MAKE SIMMONDS YOUR SOURCE FOR *ADVANCED* AIRCRAFT ACCESSORIES

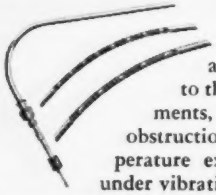
As recognized leaders in the design and manufacture of precision electronic, mechanical and hydraulic equipment, the Simmonds development group presents a growing line of advanced products, proven to the latest specifications of the U.S. aircraft industry.



THE NEW SIMMONDS PACITRON ELECTRONIC FUEL GAGE

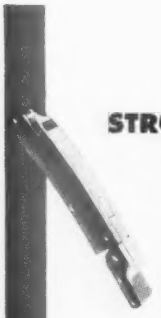
More than twenty U.S. and foreign airlines are equipped with Simmonds electronic fuel gages. Now available is the new lightweight Pacitron system with the miniaturized amplifier-bridge — lightest and most compact unit of its type available. The reliability and rugged service which have uniformly characterized Simmonds gages have established their leadership in the field of electronic fuel gaging.

SIMMONDS PRECISION PUSH-PULL CONTROL SYSTEMS



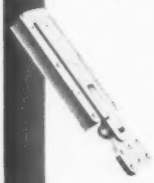
Simmonds controls are positive, precise and versatile. Adaptable to the most complex requirements, such as bends around obstructions, operation under temperature extremes, precise control under vibration. Typical applications are operation of pressurized door controls, propeller governors, parking brakes, etc. Write for new, complete design manual.

Manufacturers of Specialized Electronic, Mechanical and Hydraulic Equipment for Aircraft



STRONG LIGHTWEIGHT COWLING LATCH

In weights of only 6 oz. and 8 oz. withstands 7,000 lbs. in both tension and shear. Flush-fitting. Cowling pull-up adjustment. Simple construction—just housing and toggle. For hinged or detachable panels. Accommodates principal cowling curvatures. Send for data sheet.



HIGH STRENGTH ACCESS LATCH

Weighs only 3.2 ounces, yet takes ultimate load of 2,700 lbs. tension, 5,000 lbs. shear. For panels, cargo doors, radomes and similar surfaces. Pull-up and adjustment features. Flush when installed; gives positive lock, yet unlocks with finger pressure. Only two parts, toggle action.

HYDRAULIC FUSE

This quantity measuring fuse acts as an automatic shut-off for aircraft hydraulic systems. It closes whenever more than a predetermined amount of liquid passes through the line.

Look to Simmonds for the Finest in Advanced Air Accessories

SIMMONDS

ACCESSORIES, INC.

TARRYTOWN, N. Y.

MANUFACTURING PLANTS — Bridgeport, Hartford, Danbury, Connecticut

BRANCH OFFICES — Cleveland, Ohio • Dayton, Ohio • Dallas, Tex. • Washington, D.C. • Montreal, Canada

AERONAUTICAL ENGINEERING REVIEW

Cover—Republic Aviation Corporation's XF-91 interceptor recently made the first supersonic rocket-powered flight that has ever been flown by an American combat-type fighter. The sweptback wings of this interceptor are inversely tapered, have leading-edge slots, and have a variable incidence that permits changes in the angle of attack. The XF-91 has tandem-type landing gear under each wing. It is powered by General Electric Company's J-47 with afterburner and has as auxiliary power for supersonic speeds a 6,000-lb.-thrust rocket engine manufactured by Reaction Motors, Inc.

Editor
Welman A. Shrader

Managing Editor
Berneice H. Jarck

Assistant Editor
Rita J. Turino

Reviews Editor
F. J. Harsaghy, Jr.

News Editor
Beverly A. Dodge

Book Reviews Editor
John J. Glennon

Technical Advisers
Hugh L. Dryden
Robert R. Dexter
S. Paul Johnston

Advertising Manager
Joseph P. Ryan

Business Manager
Hugh C. Judge

Adv. Production Mgr.
R. N. Lipner

Western Office
7660 Beverly Blvd., Los Angeles 36, Calif.

SUBSCRIPTION RATES

Aeronautical Engineering Review: United States and possessions, 1 year, $3.00; single copies, $0.50. Foreign countries including Canada (American Currency Rates), 1 year, $3.50; single copies, $0.50.

Entered as second-class matter at the Post Office, Easton, Pa., April 29, 1942. Acceptance for mailing at a Special Rate of Postage as provided for in the Act of August 24, 1912.

Publication Office: 20th & Northampton Streets, Easton, Pa.

Editorial Office: 2 East 64th Street, New York 21, N. Y. Notices of change of address should be sent to the Institute at least 30 days prior to actual change of address.

Statements and opinions expressed in the Aeronautical Engineering Review are to be understood as individual expressions and not those of the Institute.

Copyright, 1953, by the Institute of the Aeronautical Sciences, Inc.

Vol. 12 **FEBRUARY, 1953** **No. 2**

Contents

I.A.S. News 15
I.A.S. News Notes. . . . . Opposite 16
Editorial 20

Articles

Reliability in Guided-Missile Systems . . . . . Richard R. Carhart 22
Large Extrusion-Press Operation and Production Problems in Aluminum . . . T. F. McCormick 27
Combat-Ready Aircraft . . . . . Col. B. A. Schriever, U.S.A.F. 34
Laboratory Simulation of Aerodynamic Heating for Transient Temperature Measurements . . . . . L. H. Wilson and J. B. Falk 39
Automatic Reduction of Wind-Tunnel Data . . . . . V. S. Haneman, L. L. Rauch, R. J. Leite, and U. A. Cotecchia 42
Eighth International Congress on Theoretical and Applied Mechanics . . . . . N. J. Hoff 48

Reviews

Aeronautical Reviews 79
Books 133

Sherman M. Fairchild Publication Fund Papers . . 33
Special I.A.S. Publications 38
I.A.S. Preprints. 76
List of Corporate Members 77
Personnel Opportunities 137
Index to Advertisers. 143

Published Monthly by the Institute of the Aeronautical Sciences, Inc.

THIS LANDING GEAR ACTUATOR
IS PRODUCED BY FOOTE BROS.
FOR THE BOEING B-47

it takes a strong arm to support the landing gear for a 185,000 pound airplane

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION

4545 SOUTH WESTERN BLVD., CHICAGO 9, ILLINOIS

I. A. S. News

A Record of People and Events of Interest to Institute Members

Sixteenth Wright Lecture

Littlewood Paper Delivered Before Seven Audiences Throughout the Country

MORE THAN 500 PEOPLE HEARD William Littlewood deliver one of the most popular talks ever given before a Wright Brothers Lecture audience in Washington, D.C., on December 17.

Additional I.A.S. groups had a similar pleasure when Otto Kirchner, Director of Operational Engineering, American Airlines, Inc., repeated Mr. Littlewood's address before other Institute Sections. At the time of this writing, the lecture was scheduled for presentation in Cleveland, Seattle, Los Angeles, San Diego, Chicago, and Langley, Va.

Tracing the history of air transportation and its equipment over the past 25 years, the speaker projected the trends into the future and expressed his fear that "...unless there is a substantial change in our attitudes and accomplishments, the manufacture of high-speed air transports will depart from these American shores just as did the Merchant Marine of the past."

Mr. Littlewood's paper evoked some interesting prepared comments in Washington by Charles Froesch, Vice-President, Engineering, Eastern Air Lines, Inc.; Col. Francis C. Gideon, U.S.A.F., Director of Operations, Military Air Transport Service; C. F. Horne, Administrator of Civil Aeronautics, Civil Aeronautics Administration; and Jerome Lederer, Director, Flight Safety Foundation and Cornell-Guggenheim Aviation Safety Center. Dr. T. P. Wright, Vice-President, Research, Cornell University, served as Chairman of the Lecture.

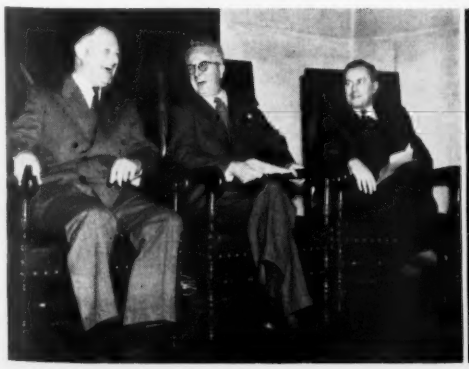
Several congratulatory cables, received from abroad and read by I.A.S. Director S. Paul Johnston, ran as follows:

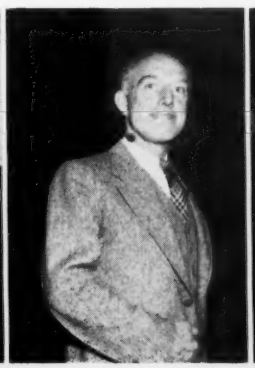
"Representatives of 14 nations attending at Roma the Second General Assembly of the Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organization extend to the Institute of Aeronautical Sciences hearty congratulations and best wishes on the occasion of the Wright Brothers Lecture and beginning of the 50th year of human flight." AGARD Chairman, Dr. Theodore von Kármán.

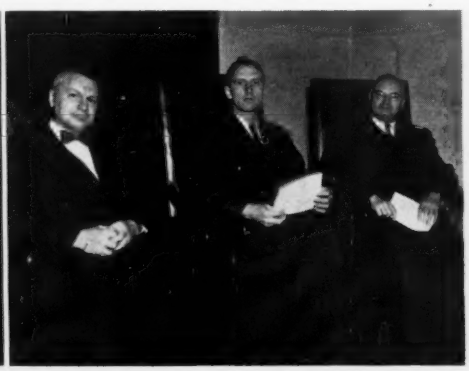
"The President, Council, and Members send you greetings on the occasion of the reading of the Sixteenth Wright Brothers Lecture by your distinguished countryman Mr. William Littlewood. Many of us will be with you in spirit and look forward to meeting many of you next September in London for the Anglo-American Aeronautical Conference." Secretary, The Royal Aeronautical Society.

The complete lecture paper, together with the prepared comments and discussions, will be published in a forthcoming issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.

Left: **Lecturer William Littlewood; T. P. Wright, Lecture Chairman; S. Paul Johnston, I.A.S. Director.** ***Center and right:*** **Discussers C. F. Horne, Jerome Lederer, Col. F. C. Gideon, U.S.A.F., and Charles Froesch.**







I.A.S. VISITS the NAVY

As guests of Rear Adm. Rice Botta, Commander of the Naval Air Material Center, and Capt. R. S. Hatcher, Commander of the Naval Air Development Center, 70 secret-cleared I.A.S. Corporate Member representatives spent November 13 and 14 viewing the valuable work being carried on at these two Navy installations in Philadelphia and Johnsville, Pa.

The two-day program included an inspection of all facilities, as well as active demonstrations and static displays of equipment developed, tested, or produced at the Centers.

Although the shows at both Centers were of a classified nature, these official Navy photographs give a good indication of the enthusiasm and interest evinced by an appreciative group of visitors.

Once again, Navy . . . "Well done!"

W. A. S.

I.A.S. News Notes

February 1953

HONORS NIGHT DINNER HIGHLIGHTS

The 21st I.A.S. Honors Night Dinner was the largest in Institute history. Approximately 1400 people heard General Hoyt S. Vandenberg present a very interesting talk on "Air Power and New Weapons." (His address will be published - along with detailed reports of the dinner and technical meetings - in the April Review.)

Honors and Awards were presented as follows: American Honorary Fellowship to James H. ("Dutch") Kindelberger; Foreign Honorary Fellowship to Charles Clement Walker of Great Britain. Eight Fellowships were bestowed upon Carlton Bioletti, Philip A. Colman, G. H. Dowty, Louis G. Dunn, Frank W. Fink, John J. Ide, Peter Masefield, and Frank N. Piasecki. Recipients of the four Awards were Lt. Col. John P. Stapp (Jeffries); Dr. Vincent J. Schaefer (Losey); John Stack (Reed); and Dr. Dean R. Chapman (Sperry).

* * * * *

"ROD" BANKS PRINCIPAL SPEAKER AT PROPULSION MEETING DINNER

Air Commodore F. R. Banks, Director, Engine Research and Development, Ministry of Supply, is scheduled to talk on engine procurement policies and methods used in Great Britain at the Flight Propulsion Meeting Dinner in Cleveland, March 13.

* * * * *

NECROLOGY

Frank P. Callahan, I.A.S. Corporate Member representative for General Electric Co., died of a cerebral hemorrhage at Schenectady, N. Y., December 21.

Major R. W. ("Shorty") Schroeder, I.A.S. Founder Member, passed away December 29 at Maywood, Ill.

* * * * *

FLUID MECHANICS CONFERENCE

The Third Midwestern Conference on Fluid Mechanics, sponsored jointly by the American Physical Society and local Sections of the I.A.S., A.I.C.E., A.S.C.E., A.S.H.V.E., and A.S.M.E., is scheduled for March 23, 24, and 25, at the University of Minnesota in Minneapolis. Dr. R. Hermann, University of Minnesota, is general chairman.

* * * * *

NEW I.A.S. CORPORATE MEMBERS

G. M. Giannini & Co., Pasadena, California, and East Orange, New Jersey.

Paul Rosenberg Associates, Mt. Vernon, New York.

* * * * *

I.A.S. News Notes (con't.)

CALENDAR OF SECTION MEETINGS

Feb. 3---Washington Section: National Museum Auditorium, 8:00 p.m. Symposium on the Development of Turbine-Powered Transports.

Feb. 4---Philadelphia Section: Engineers Club of Philadelphia, Dinner, 7:00 p.m.; Meeting, 8:00 p.m. Name of the speaker and subject of his talk unkown at press time.

Feb. 5---Chicago Section: Museum of Science and Industry, 8:00 p.m. Presentation of William Littlewood's Sixteenth Wright Brothers Lecture on "Technical Trends in Air Transport" by Otto E. Kirchner, American Airlines, Inc.

Feb. 11---Buffalo Section: Touraine Hotel, Social Hour, 7:30 p.m.; Meeting, 8:00 p.m. Robert M. Stanley, President, Stanley Aviation Corp., to speak on jet aircraft development in the United States. Talk accompanied by General Electric film, "Jet Story."

Feb. 17---Cleveland-Akron Section: University Club, Akron, Ohio, Dinner, 6:30 p.m.; Meeting, 8:00 p.m. "The Place for Naval Aviation Under the Influence of Supersonic Flight and Atomic Weapons" by Vice Adm. Paul Pihl, U.S.N. (Dinner Meeting sponsored by General Tire and Rubber Company.)

Feb. 17---Ottawa Aeronautical Society: National Research Council Auditorium, 8:15 p.m. "The Search for Lighter Structural Materials" by R. S. D. Collins, Aluminum Company of Canada.

Feb. 19---Seattle Section: Sand Point Naval Air Station, 7:30 p.m. "Helicopter Design Problems" by Dr. Kurt Hohenemser, McDonnell Aircraft Corp.

Feb. 24---Hagerstown Section: Location not known at press time, 7:30 p.m. "Military Air Cargo Trends" by Walter Tydon, Chief Engineer, Fairchild Aircraft Division, Fairchild Engine and Airplane Corporation.

Feb. 26---San Diego Section: I.A.S. Building, 7:00 p.m. "The Attainment of Greater Safety" by Benny Howard, Aviation Consultant.

Mar. 2---Boston Section: Measurements Laboratory Auditorium, General Electric Company, Lynn, Mass., 8:00 p.m. "Controls and Power Plants in Helicopter Design" by Rene Miller, Vice-President--Engineering, Kaman Aircraft Corporation.

* * * * *

CALENDAR OF I.A.S. NATIONAL MEETINGS

Mar.	13	Annual Flight Propulsion Meeting, Carter Hotel, Cleveland, Ohio.
May	20-22	I.A.S., A.I.E.E., and I.S.A. Joint International Telemetering Conference, Edgewater Beach Hotel, Chicago, Illinois.
July	15-16	Annual Summer Meeting and Honors Dinner, Los Angeles, California.
Sept.	7-17	Fourth International Aeronautical Conference, London, England.

* * * * *

MARCH REVIEW DEVOTED TO AIR SAFETY

Eight of the papers presented at the recent Air Safety Seminar in Bermuda, plus a special report by F.S.F. Director, "Jerry" Lederer, are being featured in the March Review.

* * * * *

Sir Geoffrey de Havilland Awarded Guggenheim Medal for 1952

The Daniel Guggenheim Medal for 1952 was presented to Sir Geoffrey de Havilland, Technical Director of The de Havilland Aircraft Company, Ltd., of England, at The American Society of Mechanical Engineers' annual banquet held in New York on December 3 during that society's Seventy-Third Annual Meeting. Since Sir Geoffrey was unable to attend the presentation because of illness, the award was accepted in his behalf by his son, Peter de Havilland.

Accompanying the medal was a certificate that cited Sir Geoffrey "for forty years of pioneering in military and commercial aircraft and the development of long-range jet transport."

▸ **The Medalist**—Sir Geoffrey began his aeronautical career in 1909 when he first began to design aircraft and their power plants. His first plane crashed, but the second one flew so successfully that in the summer of 1910 he learned to fly in it. The following February, he qualified for the Royal Flying Corps brevet, No. 53.

In his World War I post as Chief Designer and Pilot for The Aircraft Manufacturing Company, Ltd., of England, Sir Geoffrey designed various military aircraft. It is said that by 1918 planes of the de Havilland design comprised one-third of the total Allied air strength. He founded The de Havilland Aircraft Company, Ltd., in September of 1920.

The 1952 Guggenheim Medalist has been responsible for the designs of many production aircraft. The earlier ones included the FE-1, FE-2, BE-1, BE-2, DH-4, etc. Under his technical direction, his company pioneered the light airplane, the Moth. Among the more recent designs have been the Albatros, Flamingo, Mosquito, Vampire, Sea Venom, Chipmunk, and Comet. The Comet, the world's first jet-propelled transport, ushered in the jet-transport age on May 3, 1952, when it flew passengers and cargo between London and Johannesburg.

Sir Geoffrey is an I.A.S. Honorary Fellow and Founder Member and a Fellow of the Royal Aeronautical Society.

John Stack Co-Recipient of Collier Trophy for Second Time

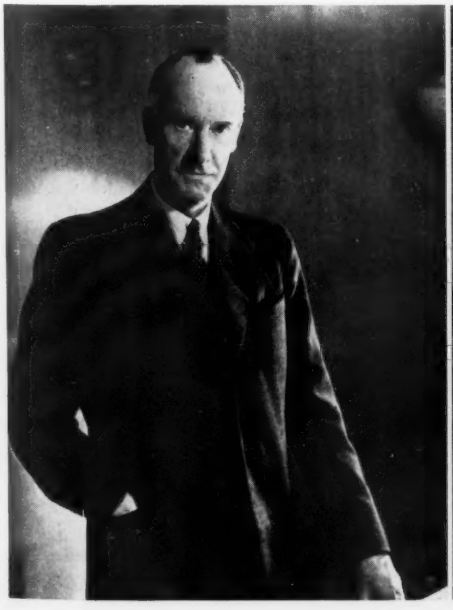
The Robert J. Collier Trophy, awarded annually "for greatest achievement in aviation in America, the value of which has been demonstrated by actual use during the preceding year," was presented for the year 1951 to John Stack, F.I.A.S., Assistant Director of N.A.C.A.'s Langley Aeronautical Laboratory, and his associates. The presentation was made by the President of the United States at the annual Wright Memorial Dinner of the Aero Club of Washington on December 17, 1952.

John Stack

Mr. Stack and his associates worked on the design, development, and application of a "transonic throat" that made it possible, for the first time, to study flow conditions over the full transonic speed range in a large wind tunnel using a large model. This device, announced in May, 1951, eliminated the old problem of "choking" which had made accurate measurements unobtainable close to the speed of sound in a wind tunnel. It made possible the use of relatively large models, capable of extensive instrumentation, for transonic studies. It was for this that the Collier Trophy for 1951 was given.

The citation accompanying the trophy reads in part: "The transonic

Guggenheim Medalist: *Sir Geoffrey de Havilland, the winner of the 1952 Guggenheim Medal, is shown in the picture at the left. In the picture on the right are his son, Peter de Havilland, who accepted the award for Sir Geoffrey, Mrs. Peter de Havilland, and Dr. Hugh L. Dryden, who made the presentation.*



wind-tunnel throat is the greatest contribution to aeronautical research since the use of a wind tunnel by the Wright Brothers in the design of the first successful airplane. . . "

The first and largest wind tunnel to be equipped with this transonic throat is the one at Langley now known as the 16-ft. transonic wind tunnel. (It was formerly called the 16-ft. high-speed wind tunnel.) Mr. Stack was in charge of all phases of the conversion work of this and other tunnels changed over for transonic research.

This presentation marks the second time that Mr. Stack has shared in this trophy. The Collier Trophy for 1947 recognized his part in making supersonic flight possible. Those receiving the 1947 trophy with him were Lawrence D. Bell, A.M.I.A.S., and Major (then Captain) Charles E. Yeager, U.S.A.F., builder and pilot, respectively, of the Bell X-1. Mr. Stack was cited at that time "for pioneering research to determine the physical laws affecting supersonic flight and for his conception of transonic research airplanes."

Mr. Stack, a native of Lowell, Mass., joined the N.A.C.A. in 1928 as a Junior Aeronautical Engineer immediately after his graduation from Massachusetts Institute of Technology with a B.S. degree in aeronautical engineering. After a short time, he became Assistant Head of the Variable-Density Wind-Tunnel Section. By 1939, he was in charge of all of N.A.C.A.'s high-speed wind tunnels and of the high-velocity airflow research, in general. Three years later, he became Chief of the newly formed Compressibility Research Division. He was appointed Assistant Chief of Research at Langley in 1947; some months ago, his title was changed to Assistant Director.

The Collier Trophy was established in 1911 by the late Robert J. Collier, of New York City, a pioneer sportsman aviator, to stimulate the development of aviation in the United States and to promote safety in flight. Awarded originally by the Aero Club of America, it has been administered since 1922 by the National Aeronautic Association.

General Doolittle Receives Wright Trophy

The 1952 Wright Brothers Memorial Trophy was awarded to Lt. Gen. James H. Doolittle, U.S.A.F. (Ret.); I.A.S. Honorary Fellow, Founder Member, and Past-President; and Vice-President of Shell Oil Company. The presentation was made at the Wright Memorial Dinner given in Washington, D.C., on December 17 by the Aero Club of Washington.

WRIGHT TROPHY PRESENTED

Lieutenant General James H. Doolittle, U.S.A.F. (Ret.), Vice-President of Shell Oil Company, is shown at the right as he receives the Wright Memorial Trophy from Harry S. Truman, then President of the United States. Harry K. Coffey (center), President of the National Aeronautic Association, watches the presentation.

This trophy, founded by Dr. Godfrey Lowell Cabot, has been presented annually since 1948 to an American citizen who has given "significant public service of enduring value to aviation." This public service must be accomplished in a civilian capacity and cover a period of years rather than a specific year. The trophy is administered by the National Aeronautic Association, and the recipient is selected by a committee composed of representatives of the N.A.A., N.A.C.A., Air Transport Association, Aircraft Industries Association, I.A.S., Aero Club of Washington, and a member of the aviation press designated by the N.A.A. President.

General Doolittle's service to aviation in a civilian capacity dates back to 1924, when he was graduated from Massachusetts Institute of Technology with an aeronautical engineering degree. (He later received M.S. and Sc.D. degrees from M.I.T.) Since that time, he has made many contributions to aviation. Among them are:

(1) In 1928 and 1929, he directed the work of the Guggenheim Foundation in the development of fog-flying equipment and on September 29, 1929, made the first successful flight—including take-off and landing—in a completely covered cockpit of an airplane.

(2) In 1934, he served as a civilian member of the War Department Special Committee on the Army Air Corps (Baker Board), which endorsed a G.H.Q. Air Force.

(3) He was an organizer of the Air Force Association, its first President in 1947, and Chairman of the Board in 1948–1949.

(4) Since 1948, he has served as an N.A.C.A. member and Chairman of its Panel on Research Facilities.

(5) In 1948–1949, he was an Advisor to the Commission on National Security Organizations and the Joint Congressional Aviation Policy Board.

(6) He has been Special Advisor on Technical Matters to the Chief of Staff, U.S.A.F., since 1950 and to the Secretary of the Air Force since 1952.

(7) In 1952, he chairmanned the President's Airport Commission (Doolittle Commission).

(8) In 1952, he became Chairman of the National Committee established to commemorate the fiftieth anniversary of the Wright Brothers 1903 flight.

Flight Safety Foundation Presents Awards

Four awards for distinguished achievement in safer utilization of aircraft were presented by Flight Safety Foundation during its annual air-safety seminar held last November in Bermuda.

The awards, donated in the interest of air safety by *Aviation Week*, were given to the following: the Directorate of Flight Safety Research, U.S.A.F., Washington, D.C.; Republic Aviation Corporation and William I. Stieglitz, A.F.I.A.S.; Capt. P. P. Cocquyt, Chief Pilot of Sabena (Belgian) Air Lines; and John E. Lindberg, Jr., President of Lindberg Instrument Company.

The Directorate of Flight Safety Research received an award for inspiring design engineers to consider safety as an integral part of airplane operating efficiency and for establishing the first university course in the principles of air safety and accident investigation. The award was accepted for the Directorate by Brig. Gen. Richard J. O'Keefe, Director.

Republic Aviation Corporation was cited for creating an Aircraft Design Department specializing in safety, and Mr. Stieglitz was cited for his work as Design Safety Engineer for the corporation. The award was accepted jointly by Alexander Kartveli, F.I.A.S., Republic's Vice-President and Chief Engineer, and Mr. Stieglitz.

The citation accompanying the award to Captain Cocquyt stated that it was given for developing a theory of sensory illusions which explains several mysterious air accidents and offers the hope of averting future accidents.

Mr. Lindberg received his award for developing the electronic engine analyzer, which enables an aircraft crew to isolate power-plant trouble in flight. The citation also commends Pan American World Airways, Inc., and Sperry Gyroscope Company, Division of The Sperry Corporation, for their cooperation with Mr. Lindberg.

Frye Trophy: *Jack Frye, F.I.A.S., Chairman of the Board and President, General Aniline & Film Corporation, presents the Frye Trophy for 1952 to Douglas Campbell, A.M.I.A.S., Vice-President and General Manager, Pan American-Grace Airways, Inc., who accepted it on behalf of Panagra. Panagra won this trophy, which was established by Mr. Frye in 1952 as an annual competitive award, for its 4,587-mile flight between Miami, Fla., and Buenos Aires, Argentina, in 16 hours and 15 min. In making the presentation last December 11, Mr. Frye stated: "This award will be given annually to encourage and recognize the advancement and continuous development and production of faster and more efficient commercial transport passenger aircraft, thereby lessening distance and lengthening time to develop world-wide communication and understanding."*

Attention Members!

All Members of the Institute are invited to submit material concerning their activities for publication in the "News of Members" columns of the *Aeronautical Engineering Review*.

News of Members

▸ **St. George Ambler Brown** (T.M.), Engineer, Engine Test Facility, ARO, Inc., has been assigned to the Ram Jet Project Branch of the Engine Test Facility. In this assignment, he will be associated with the first ramjet development test to be conducted at the Arnold Engineering Development Center.

▸ **Christopher Clarkson** (A.F.), formerly Civil Air Attaché at the British Embassy in Washington, D.C., has been appointed American technical representative for four British companies, viz., Vickers-Armstrongs, Ltd.; Dowty Equipment Company; British European Airways Corporation; and Helliwells, Ltd. Mr. Clarkson has moved his office from his former address on New York's Fifth Avenue to Room 917, 342 Madison Avenue, New York 17. His phone number remains Murray Hill 2-2618.

▸ **Dr. Hugh L. Dryden** (H.F.), Director, N.A.C.A., was elected President of the International Union for Theoretical and Applied Mechanics, which met during the Eighth International Congress for Theoretical and Applied Mechanics held at Istanbul, Turkey, in August, 1952. The Union was organized in 1946 and is sponsored by the United Nations Educational, Scientific and Cultural Organization. Dr. Dryden will serve as President of the Union for a 4-year period between 1952 and 1956.

▸ **Dr. Antonio Ferri** (A.F.), Professor of Aerodynamics, Polytechnic Institute of Brooklyn, left the United States for Rome, Italy, on December 9 on an official mission for the U.S. Air Force and the North Atlantic Treaty Organization. Dr. Ferri, in his native country of Italy, will cover the supersonic phase of an overall aerodynamics program being initiated by NATO.

▸ **Ephraim Howard** (A.F.), Staff Aero-Thermodynamicist, Engine Test Fa-

(*Continued on page 51*)

Editorial

Activity Factor

The propeller people have a formula for defining the so-called "activity factor" of any given propeller design. It entails a certain amount of calculation involving constants and squares and such, but, reduced to curbstone language, it generally adds up to the fact that there is a lot stirring around within a given small area.

The Institute can compute its own "activity factor" somewhat more simply. We don't go around in as many circles as the average propeller (we hope!), but we can point to a great deal of stirring about in a large area. We like to think that the resulting "thrust" is helping to propel aviation in America along its proper course.

One measure of I.A.S. programs is in the rising tide of Section and Branch activity throughout America and Canada. Both from the standpoint of quality and of quantity, our regional and our scholastic meetings have never been better. We commented on the quality aspects several months ago in these pages. Now our Membership Department has come up with a few statistics that show that our 25 Sections will hold over 175 technical sessions this year and that our 70 Student Branches will conduct over 350 meetings. Added together, this comes to almost two I.A.S. sessions of some kind or another per working day the year around. Not a bad "activity" rating right there.

On top of that must be added our National Meetings. These provide concentrated doses for a large group of people at intervals throughout the year. The Twenty-First Annual Meeting just closed is a fair sample. When some 1,500 people come together to sit on hard hotel chairs for 4 days in succession to listen to 50–60 papers and a few symposia tossed in for good measure, the stuff must be good.

One thing that has become more and more apparent at the National Meeting level is the ever broadening scope of subject matter. Time was when an I.A.S. meeting could be built up around a few papers on wind-tunnel results and structural studies. In those days the aeronautical engineer was either an aerodynamics expert or a specialist on continuous beams. Not so today, as a glance at the 1953 Annual Meeting Program will prove. The aeronautical engineer has become a jack-of-all-trades. The "composite" I.A.S. member (if such an animal exists) is a physicist, a mathematician, and a chemist; a sub-, trans-, and supersonic aerodynamicist; a dealer in all kinds of indeterminate structures subject to an unknown conglomerate of air loads, accelerations, and thermal stresses. He must be a physiologist and a psychologist; he dabbles in astronomics and astrophysics; and above all he must know the habits of an electron in a vacuum tube. The "need-to-know" in so many fields has had a profound effect on all I.A.S. programs.

We know, too, that to be effective in all such areas we must collaborate and cooperate with an ever widening circle of our "sister" technical societies. We have always been against any competition among such bodies. Such goings on are inefficient, wasteful, and downright silly. We have invited participation at all levels with other groups, and we have fitted our own programs into all joint efforts that seemed to further the common cause in any way. This we will continue to do.

Both from the "activity factor" angle and in line with the thoughts of the preceding paragraph, consider the overall I.A.S. program of scheduled events for the current fiscal year:

October 31, 1952: Presentation of the Musick Memorial Trophy, on behalf of the Royal New Zealand Aero Club. The Institute and The Royal Aeronautical Society are joint sponsors. Wings Club, New York.

November 13–14, 1952: Inspection Tour, Naval Air Material Center, Philadelphia, and Naval Air Development Center, Johnsville, Pa., by Institute group.

December 1, 1952: Air Cargo Day, Joint Participation with National Security Industrial Association, Society of Automotive Engineers, and The American Society of Mechanical Engineers. Hotel Statler, New York.

December 2, 1952: Heavy Press Program in collaboration with The American Society of Mechanical Engineers, Society of Automotive Engineers, and American Institute of Mining & Metallurgical Engineers. Hotel Statler, New York.

December 3, 1952: Presentation of the Daniel Guggenheim Medal at The American Society of Mechanical Engineers Dinner. (This is a joint activity with The American Society of Mechanical Engineers and the Society of Automotive Engineers.)

December 12, 1952: Second Convertiplane Congress sponsored by The Franklin Institute and assisted by the Philadelphia Section of the Institute and the American Helicopter Society.

December 17, 1952: The Sixteenth Wright Brothers Lecture, Washington, D.C., Chamber of Commerce Auditorium. The Wright Brothers Memorial Trophy and Collier Trophy for 1952 presented at Aero Club of Washington Dinner. (The Institute is represented on selection boards for both these Trophies.)

January 26–29, 1953: Twenty-First Annual Meeting, Hotel Astor, New York. Joint Sessions will be included with the American Helicopter Society, American Rocket Society, Institute of Navigation, American Meteorological Society, Institute of Radio Engineers, Radio Technical Commission for Aeronautics, Soaring Society of America, and The Daniel and Florence Guggenheim Aviation Safety Center at Cornell University.

March 13, 1953: Eighth Annual Flight Propulsion Meeting, Cleveland, Ohio. Supported by the Institute's Cleveland Section and in collaboration with the Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics.

May 20–22, 1953: International Telemetering Conference, Chicago. Held jointly by the Institute of the Aeronautical Sciences, American Institute of Electrical Engineers, Institute of Radio Engineers, and Instrument Society of America.

July 15–16, 1953: Annual Summer Meeting. Los Angeles.

September 7–17, 1953: Fourth International Aeronautical Conference, The Royal Aeronautical Society and Institute of the Aeronautical Sciences. London, England.

Obviously this is a busy year, but it is not in any sense an abnormal one. When we are not involved with meetings abroad, some other project will be coming up to take their place. This is the sort of thing your Institute will continue to do in order to push its "activity factors" to new high levels in the future.

S. P. J.

Reliability in Guided-Missile Systems

*RICHARD R. CARHART**
The RAND Corporation

The V-2 being placed in position for launching at U.S. Army Ordnance White Sands Proving Grounds, N.M., in 1946.

Introduction

Modern warfare demands the most advanced weapons that science and technology can produce. Yet the development and performance of these new weapons, with their great complexity, have focused wide attention on the increasingly critical and urgent problem of *reliability*.

The high rate of failure in military electronic equipment, due to the highly complicated nature of the problems involved, is particularly serious. To deal with this problem, the Research and Development Board in the Department of Defense established last year an Ad Hoc Group on Reliability of Electronic Equipment. An extensive survey[1] of the problem resulted in (1) a progress report embodying far-reaching conclusions and recommendations, (2) a continuing Research and Development Board electronic-reliability activity, and (3) a directive from the Secretary of Defense to the three Services stating, "Reliability must be a prime objective in *all* phases of the *procurement* and *use* of electronic equipment, beginning with the establishment of military characteristics and including operational training, maintenance, organization and facilities, as well as the quality of the equipment."

In the field of guided missiles, the reliability problem is particularly acute. It is acute partly because the whole technology of missiles is new and also because of the novel and complex mechanical and electronic devices that must operate under severe environmental conditions. Thus, the missile reliability problem includes the entire problem of electronic reliability in an exaggerated form. Reliability has been a familiar problem in missile-testing activities during the last 5 years, and, with the recent acceleration of the guided-missile program, it becomes important to focus attention on the problem of reliability in order to ensure a successful national effort in the field of guided missiles.

The purpose of this paper is to discuss the technical problem of reliability in guided-missile systems.

Statement of the Problem

Let us begin by stating the problem. Guided missiles involve the use of a multiplicity of electrical, mechanical, and electromechanical devices under severe conditions. All of these components must operate during the time the missile is in the air. In addition, before and during the flight phase, an organization of men and machines must also perform properly on the ground, on shipboard, or in aircraft. And finally, a complex man-machine support system must function properly in development, production, supply, testing, and maintenance to ensure the desired operation of the guided-missile system. *The problem is to achieve and maintain optimum reliability in guided-missile systems, including both men and machines.*

Several terms in this statement need emphasis. First, the objective is to *achieve and maintain* relia-

Presented to the Los Angeles Section, I.A.S., Los Angeles, November 6, 1952.

* Physicist.

bility, so that reliability is a problem throughout the service life of the missile and is not merely a matter of "debugging" the bird and system during its development. Second, "reliability" means probability of success; more specifically, *the reliability of a given component or system is the probability that it will perform its required function under operational conditions for a specified operating time.* As an example consider a rocket motor. One of its performance parameters is the thrust. Suppose that for successful motor performance the thrust must lie within certain limits for a specified time. These performance limits, together with the required operating time, define the task, that is—the performance requirements. A motor whose thrust lies within the task limits for the required time is successful; one whose thrust falls outside the limits during performance fails.

The distribution of performances can be established by measuring the thrust of a number of motors. Most of the thrust values initially will lie inside the task limits. During the operating time, however, some of them will drift outside, and the performance distribution function broadens. At the end of the operating period, a certain fraction of the motors will still have thrusts within the task limits. This fraction is the probability that a motor will perform within the task limits during the operating period and is numerically equal to the reliability.

Similar remarks hold for the remaining performance parameters of the motor. In general, the performance distribution will thus include all the operating characteristics necessary to determine the state of the system for the purpose at hand, and, in the same way, the task will include all the performance limits so that each performance parameter in the performance distribution is matched by performance limits in the task. The reliability of the system is then the probability that all the performance parameters lie within their task limits for the duration of the operating period.

It is important to note that the reliability depends not only on the spread of the system *performances* (which is affected by the environment) but also on the *task* and the *operating time*. In general, the reliability of a system is decreased if the task limits are narrowed or if the operating time is increased. The reliability also tends to be lowered if the performance spread is broadened, either through less quality control or through increased environmental severity. For example, in a guidance system, high temperatures in flight may broaden the spread in electron-tube performance far beyond that found under laboratory conditions, with a consequent decrease in guidance reliability.

In the case of missiles, it is convenient to exclude from reliability those failures caused by direct enemy action and to treat them separately under *vulnerability*.

Reliability may be split further into so-called "aborts" and "inaccurates." Aborts are failures that result in drastic, unusual, and unexpected performances lying far outside the normal performance spread. This normal spread is then considered under accuracy, and reliability becomes the probability that the missile will not abort. This split of reliability into accuracy and nonabort probability is useful in some cases but is artificial since many marginal failures in the *components* (in the guidance, for example) may result in *missile* aborts. Thus, system accuracy and reliability are interrelated by the marginal performance of components.

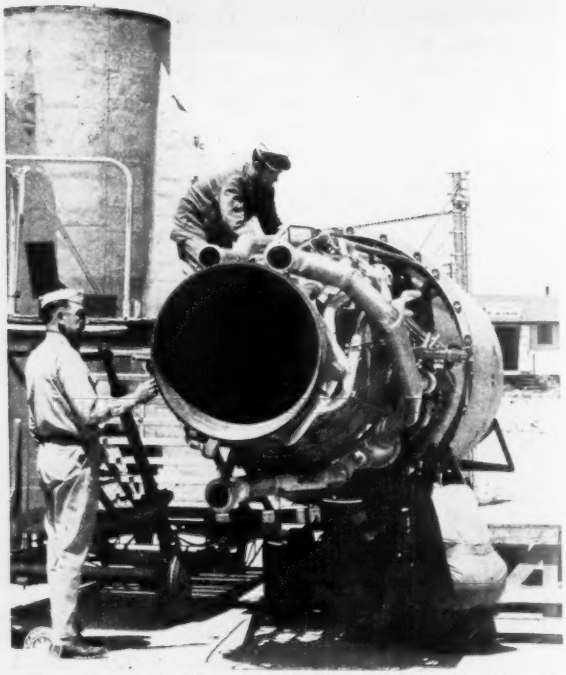
Why Is the Problem Difficult?

Now let us see why the reliability problem is difficult. Improving reliability is of course part of the development, production, and use of any new technological device. For relatively simple systems, there is a definite period of "debugging" in which the faults are easy to detect and eliminate, and the reliability problem is solved. In large systems, however, the problems of finding and curing the ailments increase rapidly with complexity and require a more scientific approach, which will be called reliability control and discussed briefly later in the paper.

Guided missiles are at the forefront of modern science and technology, and missile engineering requires the integration of new fields of aerodynamics, propulsion, servo-mechanics, and electronics. In addition, the whole missile industry is having "growing pains" under the impetus of the present accelerated programs. These are all general reasons why reliability is a problem in guided missiles, and they are common to other weapons as well.

In addition, there are six technical factors that make the reliability problem particularly serious in guided missiles.

(1) *Complexity.*—Modern guided-missile systems are extremely complex in terms of both the number of parts in the structure and their many interactions in functions. This high degree of complexity tends to increase the chances of failure. For a missile with 50 components in series, each with a reliability of 99 per cent, the overall reliability is only 60 per cent. For a system of 300 such components, the probability of success is only 5 per cent! In piloted aircraft an abort rate of about 5 per cent is generally considered acceptable.[2] If missiles carrying atomic warheads were involved, this rate would mean "throwing away" 5 per cent of the atomic-missile stockpile, since the warhead can rarely be recovered from a missile that really "aborts."[2] Nevertheless, let us use the figure of 5 per cent aborts to see what the average component reliability would have to be. If the missile were considered to consist of five components (e.g., motor, control system, guidance system, fuze, and warhead), the failure rate of each would have to be only 1 per cent. If the missile were broken into 50 smaller components, the failure rate would have to be only 0.1 per cent; in other words, the average component reliability would have to be 99.9 per cent! The moral to be drawn from these complexity arguments is simple. The failure



Preparatory to the firing of the V-2 Rocket at White Sands Proving Grounds, N.M., May 19, 1946, many intricate details were necessary in assembling the missile for the tests. U.S. Army Ordnance personnel put finishing touches to the rocket before hauling it to the launching site.

rate of the major components of a missile system must be at least an order of magnitude smaller than the failure rate of the missile itself, while the failure rate of the many parts (such as motors, vacuum tubes, valves, etc.) must be several orders of magnitude smaller than the failure rate of the missile.

(2) *Lack of Component Redundancy.*—Most of the components of a missile system are in *series*, in the sense that any failure of a component fails the missile. Considering the components as links in the chain comprising the missile, it is clear that the chain is literally no stronger than its weakest link; the system cannot be more reliable than its least reliable component. This is in strong contrast to a piloted aircraft, for example, where the probability of failure is greatly reduced through redundancy by having stand-by components and a copilot—that is, by having parallel links in the chain.

(3) *Lack of Feedback.*—In order to detect and cure failures, it is necessary to determine the *cause* of failure. This is not an easy task even in ordinary engineering work where direct inspection and instrumentation are possible during the operation. In missiles it is a far more difficult problem because the feedback of information on failures occurring during flight is inadequate, especially under operational conditions, and, in most cases, the missile is not recoverable for an autopsy. This means that many test flights are necessary, with much expensive telemetering instrumentation to monitor the operation of the components.

(4) *Severe Environments.*—The fourth factor concerns environmental conditions. There is little good data on many of the environmental stresses in shock and vibration, temperature, pressure, and humidity which the missile must withstand in transportation, handling, launching, and flight, and some of these stresses are known to be very severe. For example, a Signal Corps report (Ref. 9) recommends that to simulate typical field handling conditions, electronic equipment should be tested by dropping it 5 feet onto soil or concrete, during which it will suffer from 200 to 500 g's acceleration for several milliseconds. Without good environmental data it is difficult either to design adequate safety margins into the components or to perform realistic environmental tests.

(5) *Weight and Space Requirements.*—The fifth factor involves weight and space requirements, which impose severe limitations on the design and packaging of components; these factors, together with the high performance required of the components, result in small safety margins against failure. This is particularly important in the electronic equipment, where low weight factors favor fragile mechanical construction and the small space available makes it difficult to design for adequate cooling and accessibility.

(6) *Electronic Reliability*—Missile performance and reliability are critically dependent on the electronic equipment of the guidance and control functions. It is well known that the reliability of military electronic equipment is low; for example, it is estimated that only about one-third of the Navy's shipboard electronic gear is operating properly.[1] This is particularly true for those missile systems in which the major part of the guidance equipment is air-borne in the missile itself. In general, it appears that electronic reliability is the most important part of the missile reliability problem. Indeed, Major General Putt of the Air Force Research and Development Command recently stated that "the scheduled introduction of guided missiles into operational units depends primarily on the accuracy and reliability of guidance and control systems."[2]

In view of these six factors, it is extremely clear that the problem of achieving and maintaining reliability in guided-missile systems is important and difficult. It is a serious challenge to both the Armed Services and the industry.

The V-2 Reliability

A brief review of the German V-2 history will help to set the problem in historical perspective. The first experimental work at Peenemunde began in 1933, with the A-1 rocket weighing 150 kg., and was followed in 1934 by the A-2, which reached a height of 2,000 m. As early as 1935, German authorities gave serious consideration to the military applications of rockets. Basic research had begun several years earlier, and much effort was put into this field. As a result, there was a base of industrial support for missile designers.

Rocket motors and fuels were commercially available and during the next few years a series of high-speed wind tunnels and jet-engine test stands was built. From 1936 to 1942, about $500,000,000 were spent in developing the Peenemunde Rocket Center. By 1942 nearly 6,000 people were employed, about 2,000 of whom were scientists and engineers.[3] This program involved more than one-third of Germany's entire aerodynamic research. In 1938 the first experiments were made with the A-3 and later with the A-5. These were small scale V-2's about 25 ft. long, weighing 800 kg. Many of these A-3's and A-5's were fired and gave valuable experience and technical data.

In 1940 work was begun on the V-2, and on July 6, 1942, the first V-2 was fired. It rose precisely 3 ft. off the ground and then exploded with enormous violence, destroying the test station. Numbers 2 and 3 also exploded but at 16,000 ft. Finally, number 4 was a success; in October, 1942, it covered a distance of 170 miles. Number 5, fired a short time later, was also a success, but the next 13 were failures. Thus, out of the first 18 rockets only two performed successfully, giving a reliability of 11 per cent. During the 3 years of development, testing, and training, some 3,000 V-2's were fired. Problem after problem arose in the motor, air frame, and control system. For example, it was found that of the rockets that were launched successfully, about half broke up in the air, and a large scale theoretical and experimental study involving about 300 V-2 launchings was required to solve the air-burst problem, which turned out to be caused by an aerodynamic deficiency. In all, some 62,000 changes were made during the production of the V-2, which consisted of about 30,000 different construction and engine parts. Finally, in September, 1944, 10 years after the first test rocket firings at Peenemunde, the first V-2 was fired against London. By April, 1945, when the V-2 campaign ended, about 2,700 V-2's had been fired against London and Antwerp, with a reliability of 75 or 80 per cent and an accuracy much lower than was called for in the military plans.[5]

After the war, a number of V-2's were captured and taken to White Sands for tests.[6] During the 5-year program, 68 V2's were fired, of which 32 were successful. Of the 36 failures, 10 occurred during launching, and the remaining 26 were evenly divided between motor and steering malfunctions. Thus, the reliability during the American V-2 firings was 47 per cent as compared with the German combat reliability of 75 per cent. This well illustrates the difficulty of obtaining a high reliability; even with German experience and technical personnel, more than half the missiles failed in the American tests. In view of the remarks concerning the difficulty of determining cause of failure from flight tests, it is of interest to note that, of the 36 V-2 failures, in only 6 cases was the *cause* of failure established; in 14 cases, it was known *what* failed but not *why;* for the remaining 16 cases, only the general *area* of failure was known. Thus, in only $^1/_6$ of the failures was the cause of failure ascertained so that the failed component could be immediately improved. While the sample is too small to draw general conclusions from it, it indicates the high price paid for failure information in missile test flights.

Achieving and Maintaining Reliability

Let us return to the problem of achieving reliability. The objective of a missile project is to develop a producible and reliable missile. Until performance capability has been demonstrated, reliability is secondary in importance; when the required capability has been demonstrated, however, reliability becomes of primary importance. Unless an adequate combat reliability is achieved, the missile is ineffective as a military weapon. The improvement of system reliability is therefore a vital phase of any weapon development.

The reliability of a missile system can be improved in four fundamental ways.

(1) *Improved Components.*—The use of more reliable components is the usual way to increase system reliability and offers the only long-term means of making large improvements in reliability.

(2) *Improved Design.*—Improved system and component design may increase reliability by decreasing complexity, increasing safety margins against failure, and improving maintenance and operator effectiveness. The opportunities for increasing reliability by improving design appear particularly hopeful for electronic equipment in missile systems.

(3) *Improved Selection and Training of Personnel and Standard Operating Procedures.*—Reliability can be increased by improving the quality and effectiveness of the skilled personnel, both military and civilian, who are required in the assembly, inspection, packaging, handling, testing, maintenance, and operation of guided missiles.

(4) *Component Redundancy.*—The use of stand-by components in case of failure increases reliability, provided the switching or decision device is reliable. The method may be costly (e.g., in dollars and weight) but may be justified. Most important, it does not require improved components. For example, suppose the guidance system has a reliability of 75 per cent, or a failure rate of one-fourth. Now replace the single system by two of these guidance systems in parallel so that if one fails the other takes over. For missile failure to occur, it is now necessary that both guidance systems fail so that the failure probability is $^1/_4$ times $^1/_4$, or $^1/_{16}$, or 6 per cent. Hence the reliability is 94 per cent, a significant increase over the original 75 per cent.

In order to make these improvements in all the various phases of missile development, it is necessary to obtain technical information on failures. More specifically, statistical data are required on the number of failures, the identity of the failed components, the time of failure, and the causes of failure. Statistical information of this type is costly and difficult to obtain from test flights. The most hopeful approaches

seem to lie in the use of recoverable missiles and in simulation tests in which the missile is subjected to environmental conditions experienced in shipping and handling, in launching, and in flight. Shock and vibration conditions are important potential sources of failure in all phases. In order to determine a realistic mixture of environmental stresses for testing, good data are needed on the shock and vibration, temperature, pressure, and humidity experienced by an actual missile in traveling from the factory to the target. Unless good environmental data are obtained, there is the danger that missiles and their components will be designed to survive the simulation test environments rather than the actual operational environment. In addition, since there is always a variety of failure causes, a statistical approach is necessary to ensure that the defects are cured systematically in the order of their importance rather than in the order of their accidental appearance in tests.

Finally, having achieved and demonstrated an adequate reliability to justify service acceptance, the missile system is put into production and service use, and the problem of *maintaining* the reliability becomes vital. This requires a failure-monitoring activity similar to quality control. Continuous and rapid reports on failures are needed to evaluate the reliability and ensure that it lies within acceptable limits. Failures in transit, handling, storage, testing, and operational use should be analyzed to detect and eliminate sources of trouble.

System Reliability Control, the Analog of Component Quality Control

How should all these technical activities be efficiently coordinated? In a simple device reliability is achieved by recognizing faults when they occur and eliminating them. In a complex guided-missile system, this simple approach is correct in principle but costly and time-consuming in practice. As in any scientific or engineering project, it is therefore necessary to organize and direct the technical effort required to solve the reliability problem in systems. This organized systems activity will be called reliability control; it is the systems analog to component quality control used to maintain quality in manufactured components. More exactly, *by reliability control I mean the coordination and direction of technical reliability activities through scientific planning from a systems point of view.*

Reliability control consists of the following cycle of five steps:

(1) *Determination of Requirements.*—Reliability requirements must be established for the system and its components. From the definition of reliability, this demands specification of the required performance limits, the operating time, and the environment, as well as the required reliability.

(2) *Collection of Data.*—Reliability data on component and system failures and their causes must be collected in statistically significant amounts.

(3) *Analysis.*—The data must be analyzed to determine whether the requirements are met, to establish the most important causes of failure, and to recommend methods of improvement.

(4) *Improvement.*—Action must be taken to remove the most important defects and reduce the failure rate to the required level.

(5) *Surveillance.*—A continuous and critical surveillance of the system must be carried out to ensure that the "improvements" actually reduce the failures, to anticipate and examine new and unsuspected sources of failure, and to review and modify requirements.

There is no sharp distinction between reliability control and the usual engineering methods of improving reliability. Nevertheless, it is important to recognize that reliability control differs in degree from conventional engineering in three respects: first, overall system planning is emphasized; second, statistical analysis of failure data is used as a *control;* and, third, constant surveillance of the system through feedback of failure data is required in all phases of development and production.

Conclusion

In conclusion I would like to emphasize three points:

(1) Reliability of the hardware in a missile system is fundamentally the result of engineering that takes into account, realistically and from a systems point of view, all the significant factors affecting the performance of the weapon.

(2) Reliability is a difficult and important technical problem that requires careful planning, a large effort, and great attention to details.

(3) Reliability and the associated problem of accuracy are the primary factors governing the time at which guided-missile systems will become operational. Without adequate attention to reliability, both on the part of the using Services and the contractors, these operational dates will be delayed.

References

[1] *Reliability of Electronic Equipment,* Research and Development Board, Report EL200/17, Vol. I, February 18, 1952.

[2] Putt, Major Gen. Donald L., *Freedom from Human Frailty,* Air Force, p. 57, February, 1952.

[3] Ehricks, Kraft A., *The Peenemunde Rocket Center,* Rocket Science, June, 1950.

[4] Ley, Willy, *Rockets and Space Travel,* p. 220; The Viking Press, New York, 1947.

[5] Kooy, J. M. J., and Uytenbogaart, J. W. H., *Ballistics of the Future,* p. 285; Tech. Publishing Company, H. Stam, Haarlem, Holland, 1947.

[6] *What We Have Learned from V-2 Firings,* Aviation Week, Vol. 55, No. 22, p. 23, November 26, 1951.

[7] *Transactions of the I.R.E.* (Professional Group on Quality Control), August, 1952.

[8] *Symposium on the Application of Tubes in Guided Missiles for Maximum Reliability,* Research & Development Board, 1952.

[9] *Mechanical Engineering as Applied to Military Electronic Equipment,* Signal Corps Engineering Labs., Technical Memo. No. M-1177, June 22, 1949.

Large Extrusion-Press Operation and Production Problems in Aluminum

T. F. McCORMICK*

Aluminum Company of America

Introduction

GIANT PRESSES NOW UNDER CONSTRUCTION or planned in this country will enlarge severalfold the size of light-metal shapes and tubes which may be extruded. The operation of the new presses will present many production problems, both predicted and unpredicted, but at the same time will permit the extrusion of large or intricate shapes that lead to economy and versatility in aircraft construction. This article is intended to review operating techniques and problems associated with present large extrusion presses and to indicate some of the expected problems that will arise in production of extruded shapes on such presses as the 14,000-ton press now being installed at Aluminum Company of America's Lafayette, Ind., Works.

Extrusion is a comparatively new manufacturing method largely developed within the present century for the fabrication of wrought metal shapes and tubes. In a relatively short period, extrusion has become established as one of the most important methods for manufacturing widely used shapes, particularly in the light-metal industry.

Before discussing the production problems associated with the operation of large extrusion presses, it might be well to explain what is meant by a large press. The largest extrusion press in operation in this country today has a rated capacity of 5,500 tons. The size most commonly used for producing the types of extrusions used in aircraft is the 2,500-ton press. There is a distinct break between the ingot sizes used and the extrusions produced with 2,500- and 4,000-ton presses. On this basis a press with a rated capacity of 4,000 tons or more can be considered a large extrusion press.

Extrusion Equipment

With few exceptions, the extrusion presses used in this country today for producing light-metal extruded shapes and tubes are of horizontal rather than vertical type, operate by pressure applied hydraulically, and employ the direct method of extrusion.

With present extrusion presses, the bore of the largest cylinder liners will handle ingots approximately 18 in. in diameter and 44 in. long. In the aluminum alloys, such an ingot should produce a finished extrusion of about 800 lbs. However, with the 5,500-ton press, only 40,000 lb. per sq. in. pressure could be applied against the ingot. This is insufficient for the strong alloys unless the ingot length is greatly reduced or the shape produced is large and simple in design. For aircraft extrusions cylinder liners fitting ingots 11 in. and 14 in. in diameter are used most extensively in the present large presses, although 16-in. diameter ingots can be and are extruded into certain types of sections from the strongest alloys. Thus, the usual limit of extruded shapes with present presses is about 600 lbs.

The first of the very large extrusion presses in the United States Air Force program, which will begin operation about the middle of 1953 at Alcoa's Lafayette Works, has a rated capacity of 14,000 tons, two and one-half times greater than equipment now in operation. The inside diameter of cylinder liners will vary from $15^1/_4$ in. to $29^1/_4$ in. and be of sufficient length to handle ingots 70 in. long. Contemplated manufacturing limits for solid shapes produced with this press and its planned auxiliary equipment have been established with a maximum length of heat-treated aluminum-alloy extrusion of 90 ft., a maximum weight of 2,300 lbs., and a maximum cross section to fit within a circumscribing circle having a diameter of 23 in. Such units cannot be stated on an absolute basis, and under certain conditions, they may be exceeded. Tubes and certain hollow shapes of larger diameter are a distinct probability. The minimum thickness for the average shape that can be extruded in several aluminum alloys is shown in Table 1.

TABLE 1
Minimum Thickness Extruded with 14,000-Ton Press

Circumscribing Circle Diameter, In.	*Minimum Thickness of Solid Shapes, In.			
	3S-63S	61S-62S	14S	24S-75S
Under 13	0.093	0.109	0.125	0.156
13 to (not incl.) 16	0.109	0.125	0.156	0.187
16 to (not incl.) 19	0.125	0.140	0.171	0.250
19 to (not incl.) 23	0.140	0.156	0.187	0.375

* Greater thickness may be necessary for some shapes, whereas lesser thickness may be possible for others.

It is expected that solid ingots that fit a cylinder liner $25^1/_4$ in. in inside diameter will be the largest to be found in general usage in a 14,000-ton press. A larger cylinder will be available for extruding hollow shapes and tubes. The $25^1/_4$-in. cylinder permits the application of slightly over 50,000 lb. per sq. in. pressure to the

Presented at the Heavy Press Program for Light Metals, sponsored by the A.I.M.E., A.S.M.E., I.A.S., and S.A.E., New York, December 2, 1952.

* Metallurgist.

ingot. Sound, high-quality ingots in 75S alloy have been cast and are available for extrusion in the sizes needed.

At the time of this writing, no photographs of the assembled press are available, but some idea of its size can be gained from the fact that the foundation for the press is 172 ft. long, 53 ft. wide, and 13–17 ft. deep. This does not include the runout table, which will add considerably to the total length.

Extrusion Tools

Extrusion tools present a severe test for steels, since, at the relatively high temperatures at which they are used, they must retain their strength qualities, be subject to high stresses, have good abrasion or wear resistance, and be able to withstand shock loads. The essential extrusion tools comprising dies, mandrels, dummy blocks, backup pieces, and container liners are fabricated from high heat-resisting steels. The usual steels are of the tungsten-chromium type and may contain from 1–15 per cent tungsten and 1–12 per cent chromium with smaller additions of nickel, molybdenum, manganese, vanadium, or silicon, depending upon the metal being extruded or the exact tool being used.

Diemaking in the extrusion industry is considered an art, although extensive experimental work has been conducted to establish engineering principles, ascertain working formulas, and set up die design on a scientific basis. Much has been accomplished, but it is not yet possible to design and build a die for a complicated shape with complete assurance that it will produce a usable extrusion the first time it is tried. Dies for many nonsymmetrical shapes may be tried and altered several times before a satisfactory extrusion is obtained, particularly with dies for large presses. Making extensive alterations is expensive, time consuming for press and man power, and wasteful of ingot stock. Fortunately, enough is known about die building so that it is rarely necessary to construct a new die in order to make the required alteration.

The die designer must consider the characteristics of the alloy to be extruded, make allowances for stress and distortion, for thermal contraction of the extruded shape following extrusion, and for reduction in thickness on stretching to obtain straightness, and also to balance the metal flow for uniform velocity through all parts of the die opening.

The pressure applied against the ingot to cause extrusion is not transmitted uniformly through the ingot to the die face. Friction between the ingot and the inside wall of the cylinder liner exerts a retarding influence, thus creating a tendency for the metal to flow with greater rapidity through the center portion of the die. The size of the die opening influences the ease of extrusion not only by a change in the total reduction from ingot to extruded shape but also by the fact that variations in the opening in various parts of a single die create different metal flow tendencies. For example, it is difficult to fill completely thin extending protrusions attached to a heavy body of an extrusion because of the easier flow through the larger portion of the die opening. The magnitude of the variations in flow characteristics becomes greater as ingot size or section size is increased.

It is apparent that the die designer's problems become exaggerated with large extrusion presses so that the available means of compensating for the nonuniform flow must be utilized to a greater extent. The compensating factors include varying the arrangement of the opening on the die face, providing extra width of opening for thin portions of the shape, and adjusting the bearing length in various portions of the die. Normal bearing lengths for simple extrusions may vary from $^3/_{16}$ in. to $^3/_8$ in., but, for intricate and large extrusions, bearing lengths in the large opening portion of the die may be several inches. Such bearings may be shaped to provide a choke or relief after initial construction in order to retard or speed up the flow of certain elements of the extruded shape.

A preferred die has a flat working face, and the entrance may be at a sharp 90° normal to this face with or without a slight radius on the sharp corner. Dies for the larger extrusions contain single openings, but with smaller sections, multiple openings, generally from two to eight in number, are customary. Multiple-opening dies must be constructed to produce uniform lengths from all openings.

For a shape that has extreme unbalance of flow, it is possible to provide additional compensating openings in the die. This procedure has been used only to a minor extent in this country but may be used more extensively for extruding very large sections. For extreme sections, this method could offer advantages from the standpoint of cost over the method of constructing dies with extra-long bearing lengths.

Spider, bridge, or porthole dies, as they may be termed, are used to produce hollow shapes or tubes from solid ingots. In operation the solid ingot is parted into two or more streams and then reunited in the die, the parts welding together to form a hollow extrusion. Only a few such sections have been used in aircraft construction, because they are not readily adaptable to strong alloys. The advent of larger extrusion presses offers a means of increasing the use of similar dies.

The production of stepped extrusions used extensively for aircraft wing spars is almost exclusively a feature of the large press. A die to produce a stepped extrusion is constructed with several parts. Certain parts of the die may be replaced with others providing larger openings at one or more stages during extrusion. Higher than normal extrusion pressure requirements are dictated in order to permit extrusion of an initial small section and provide sufficient cylinder size for adequate extrusion ratio for the larger final section.

Extrusions tapered from end to end have received consideration from several experimenters. It is generally conceded that the best method of producing tapered sections is to group a number of them in a symmetrical design around a mandrel so contoured as to

produce the desired taper. Production of this type of section is limited with present extrusion presses, but the very large presses will make the method more attractive.

Mandrels for hollow shapes and tubes generally contain a slight taper. Thus, the inside diameter of a tube will be slightly smaller at the start of extrusion than at the finish. The amount of this taper has been substantially decreased during recent years, and it is now possible to produce extruded tubes to close dimensional tolerances, whereas previously it was considered necessary to utilize cold-drawing for a sizing operation. This development has markedly decreased the cost of light-metal tube and pipe. Careful alignment of the extrusion press, as well as close control of ingot and cylinder liner sizes, is necessary for producing close-tolerance extruded tubes. The larger presses will permit extending the size range upward. In fact, the largest of the cylinder sizes are being obtained for this purpose.

With the large presses, tool costs are high, and extreme care must be exercised in their use. Adequate backup tools are required to prevent excessive die breakage. An enormous energy is available for use. Well-designed tools can utilize it with efficiency, but poor tools spell catastrophe.

Extrusion Practices

A few of the small extrusion presses in this country are operated by the indirect method, but the direct method is the most common and is used for all large presses except in rare cases where a combination of the two methods may be employed. Direct extrusion has found widespread use principally because tooling is simpler, extrusions of greater width can be produced, surface quality is better, and it is more easily adapted to the use of multiple-hole dies. The large presses are directly tied to several of these factors. Disadvantages of the direct method are greater pressure requirements, less uniformity of working of the extrusion, and the formation of defects in the last metal to be extruded if proper practices are not employed.

The alloy to be extruded, pressure available, extrusion ratio, temperature of ingot and cylinder, and permissible extrusion speed are all interrelated variables that govern the extrusion process.

In direct extrusion, maximum pressure is required to start the extrusion, decreasing progressively as the operation proceeds. This is related to the area of contact between the ingot surface and the cylinder liner, and thus any increase in ingot length requires a corresponding increase in the pressure applied. In commercial practice the ingot length is usually within the limits of one to four times the ingot diameter. Extrusion rate is directly proportional to the pressure applied.

The ratio of the cross-sectional area of the cylinder opening to the cross-sectional area of the extrusion, termed the extrusion ratio, has a definite effect upon the pressure requirement for extrusion. As this ratio becomes smaller, less pressure is necessary, but there must be limitations. In usual practice, the extrusion ratio will vary from a minimum of 10 to over 100. One of the reasons for large extrusion presses is to produce large extrusions that are sufficiently worked to have completely wrought structures.

An increase in ingot and cylinder temperatures decreases pressure requirements for metal flow but reduces the possible extrusion speed. With alloys where extrusion speeds are slow and critical, it is the general practice to control temperatures at minimum values compatible with maximum available pressure to obtain the higher extrusion rates. Although extrusion is primarily a process where the work is done by compressive forces, tensile stresses do develop in the outer fibers of the extrusion as it passes through the die. These tensile stresses originate from the tendency for more rapid flow through the center portion of the die opening and the retarding effect of friction between the extrusion and the die bearing. When these stresses exceed the strength of the metal, surface rupture or broken surface will occur. Large die openings exaggerate the effect of the stress gradient caused by unequal flow so that for this type of section the extrusion rate is low.

Aluminum alloys like other metals decrease in strength with increasing temperature. The higher the temperature developed in the emerging extrusion, the lower the speed at which surface breaking will occur, hence, the lower the permissible extrusion speed. In aluminum alloys with low alloy content, comparatively high extrusion speeds are possible, and temperatures may reach high levels before surface rupture will occur. The high-strength alloys, because of the presence of substantial alloying constituents, will develop broken surface at lower temperatures and speeds. With such alloys speed is particularly critical and requires close control.

The general practice in extruding is to maintain the cylinder temperature lower than the ingot temperature. This practice facilitates starting the extrusion when the pressure requirement is at a maximum because of inertia and maximum contact between ingot and cylinder. After extrusion has progressed and the pressure requirement has decreased, the colder cylinder absorbs heat generated by deformation, thereby maintaining a more uniform heat balance throughout the cycle.

Another means of increasing extrusion speed (and thus production rate) for large sections and high-strength alloys is the use of a patented scheme of water-cooling the extrusion die. The cooling water removes the heat generated from the area where it is most harmful and permits speed increases of 30 to over 100 per cent in large extrusions of 75S alloy.

Auxiliary Equipment

In order to derive the utmost advantage from large extrusion presses, auxiliary equipment such as heat-treating, preheating and reheating furnaces, and

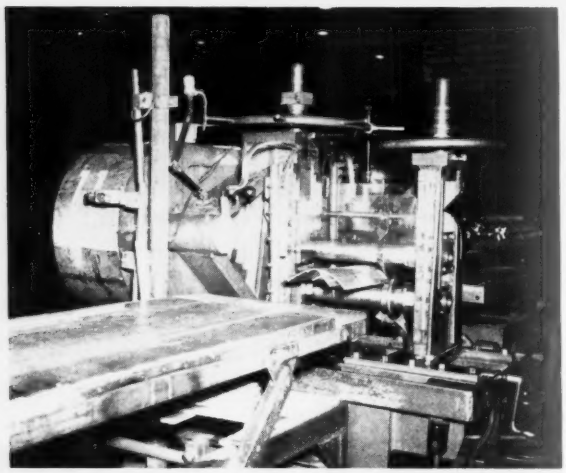


FIG. 1. One of many unusual shapes from the extrusion press is now contour rolled for a special purpose in the aircraft industry.

straightening machines must be available on a comparable basis.

Preheating is a high-temperature treatment preliminary to a hot-working operation and generally involves sufficient time to improve the homogeneity of a cast structure. The readily soluble constituents dissolve and become more uniformly distributed, and those less soluble spheroidize and agglomerate to form larger particle sizes. Changes of this type improve the hot-working characteristics of an aluminum alloy, and, for some alloys, the effects persist through subsequent operations, resulting in a finer grain size and more uniform mechanical properties in the finished product. Larger presses do not create any preheating problem other than that the furnaces must be of sufficient size to handle large ingots. Probably longer soaking times at preheating temperatures will be required. Preheating becomes of greater importance as ingot size is increased, because constituent size is larger, structures are less homogeneous, hot-working will be less in percentage total deformation and maximum aid is required to obtain reasonable extrusion speeds.

Furnaces for heating the ingots to the extrusion temperature must be provided in a size adapted to large ingots. These are termed reheating furnaces and may be of the chain-conveyer type, generally gas or oil fired. Or, such heating may be performed by induction coils. Heating rapidly by induction offers an additional advantage for alloys difficult to extrude in that the ingot may be differentially heated with a marked thermal gradient from one end to the other. This provides hot metal adjacent to the die face for ease in starting the extrusion when the pressure requirement is at a maximum, and, subsequently, it provides cooler metal to absorb the heat of deformation and permit higher extrusion rates.

Solution heat-treating and aging furnaces must handle long lengths if adequate usage is to be made of large extrusion presses. The customary vertical furnace used for extrusion heat-treatment cannot be extended economically much beyond a length permitting the production of 40-ft. extrusions. A horizontal furnace that will heat-treat large extrusions and provide finished lengths of 90 ft. is available. Aging furnaces of equivalent length are available and are used in conjunction with the solution heat-treating furnace.

The fundamental method of straightening extrusions is by stretching. Other types of straighteners, such as hydraulically operated arbor presses, motor-driven detwisters, and contour rolling machines as shown in Fig. 1 are used to supplement stretching or to straighten sections beyond the capacity of an available stretcher. However, stretching relieves internal stress resulting from heat-treat quenching and, thus, substantially minimizes distortion that may occur when contour milling aircraft parts. This is illustrated in Fig. 2. The upper three wing spars were produced from extrusions that were not stretched and the lower three from stretched extrusions. With the increase in extrusion-press size contemplated, the building of adequate stretchers becomes a real problem.

The largest stretcher now available in an extrusion plant will exert a pull of 750,000 lbs., which is sufficient to handle a 75S extrusion with a cross-section area of 15 sq.in. Larger shapes have been stretched in this alloy by carefully coordinating the heat-treatment and stretching operations. This stretcher is shown in Fig. 3.

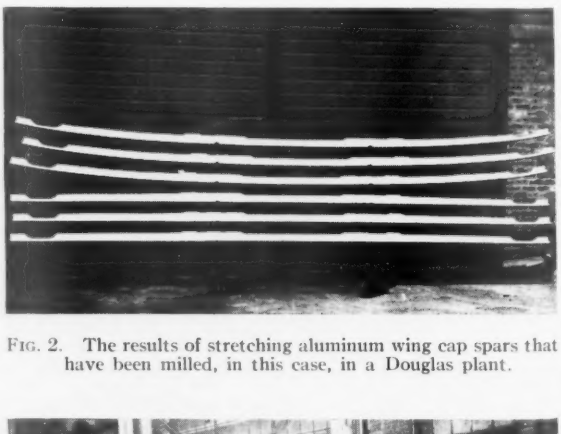


FIG. 2. The results of stretching aluminum wing cap spars that have been milled, in this case, in a Douglas plant.

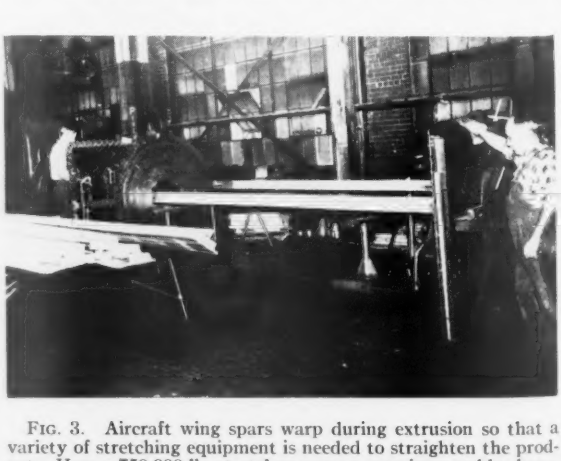


FIG. 3. Aircraft wing spars warp during extrusion so that a variety of stretching equipment is needed to straighten the product. Here a 750,000-lb. stretcher snaps a spar into usable shape.

A stretcher capable of exerting a pull of 3,000,000 lbs. is being built and installed at Alcoa's Lafayette Works to operate in conjunction with the 14,000-ton extrusion press mentioned earlier. This stretcher will be of sufficient size to straighten 75S extrusions having cross-section areas as large as 60 sq.in.

Structure Properties

Numerous studies have been made to determine the character of metal flow during extrusion. The results of such studies reach far beyond academic interest as the size of extrusions becomes larger. Practical application of the knowledge gained from metal-flow investigations has determined the cause of structural variations and formation of certain defects peculiar to the extrusion process. One procedure for studying metal flow is to section and macro-etch ingots extruded to various increments of the original length.

There are three separately distinguishable zones of deformation in an aluminum-alloy ingot during extrusion. A zone that remains relatively immobile lies immediately adjacent to the shoulders of the die and the neighboring cylinder wall. Immediately in front of the die opening is a funnel-shaped region in which the principal deformation occurs. This region possesses two zones. In the central zone, the metal flows most rapidly, and deformation occurs primarily by a simple elongation corresponding closely to the actual change in cross section between the ingot and the extrusion. Surrounding this center zone is a zone that undergoes severe deformation as the metal passes diagonally with heavy shear into the extrusion. Metal from this region forms the outer portion of the extrusion. Thus, the central portion of the extrusion experiences a lesser amount of deformation, whereas units toward the outer surface undergo successively greater deformation. Metal in the center of a vertical plane through the ingot will occur forward of metal at the outer portion of this plane in the extrusion.

The extreme front end of an extrusion receives little equivalent cold work, the amount progressively increasing as extrusion proceeds. Under certain conditions, this results in a variation of the metal structure throughout the length. The exact nature of this structure depends upon the extrusion conditions such as temperature, extrusion ratio, size, and alloy. For small sections and the softer alloys, such structural variations are relatively unimportant, but, with large extrusions of the alloy types used for aircraft constructions, the effects of each structural variation must be carefully evaluated with respect to mechanical properties. For instance, the extreme front end of a large strong-alloy extrusion will contain remnants of the ingot cast structure and must be removed.

The strong aluminum alloys do not recrystallize readily during extrusion or subsequent thermal treatments. With large sections, any recrystallization that does occur will be found in an outer band that increases in thickness toward the rear of the extrusion, and the recrystallized band may show relatively coarse grains. The center portion of the shape and, for large 75S shapes, the entire cross section will have an unrecrystallized but highly worked structure that has a high degree of preferred orientation in the longitudinal direction. It is this high degree of preferred orientation which imparts to aluminum-alloy extruded shapes high longitudinal tensile and yield strengths above those considered normal for shapes produced by other methods. Extensive use is made of this fact in the design of aircraft structures, particularly wing spars.

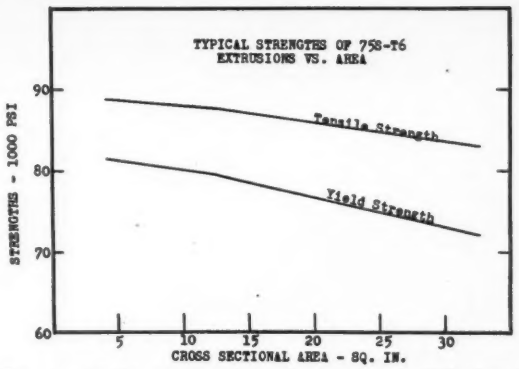


FIG. 4. As the cross sections of extrusions in 75S alloy increase in area, the strength of the product decreases slightly. Aircraft specifications covering the mechanical properties of this strong aluminum alloy recognize this fact and require higher tensile and yield strengths for the smaller sections.

Relatively thin sections receive more equivalent cold work during the extrusion operation and are thus more completely recrystallized. Aircraft specifications covering the mechanical properties of strong aluminum alloys recognize this fact and require higher tensile and yield strengths for the larger sections. However, with further increase in size of extrusion, other factors such as decreased extrusion ratio and slower quench rate from solution heat-treatment exert their influence, and mechanical properties show a tendency to lower values. This effect is illustrated in Fig. 4. Larger extrusion presses will represent a partial solution to this problem.

Information on the longitudinal tensile properties of large extrusions is available from a number of sources. As section size has increased, properties in other directions, particularly transverse properties, have become of greater importance, and aircraft designers are insisting upon the establishment of minimum specification values for such properties. In developing the reason for lower properties in the transverse and related directions, a similar extrusion was cold-worked a slight amount by stretching prior to heat-treatment, with the result that recrystallization removed the highly preferred orientation effect.

With stepped extrusions at the point of junction between two section sizes, the alignment of the structure will be at an angle to the direction of extrusion. This has a corresponding effect upon the longitudinal mechanical properties, and values somewhat lower than values at points distant from the step may be obtained.

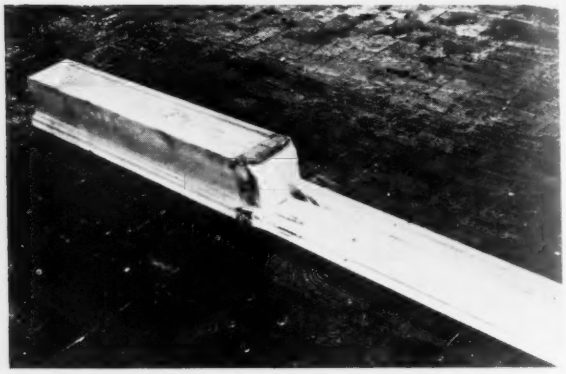


FIG. 5. Alcoa pioneered the manufacture of the stepped extrusion, which possesses the necessary strength while it results in a sharp reduction in the amount of machining time required for production of the final product in an aircraft plant.

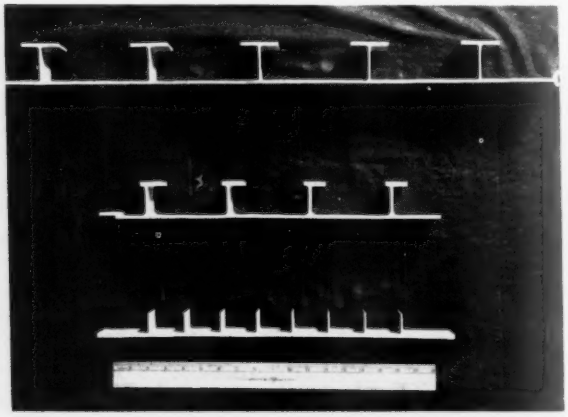


FIG. 6. Integrally rib-stiffened aircraft wing panels. The extrusion of the panels in a V-shape is simple, but straightening to the necessary flatness has presented more difficulty. The 14,000-ton press is expected to increase the possible width of such a part from 27 to 34 in.

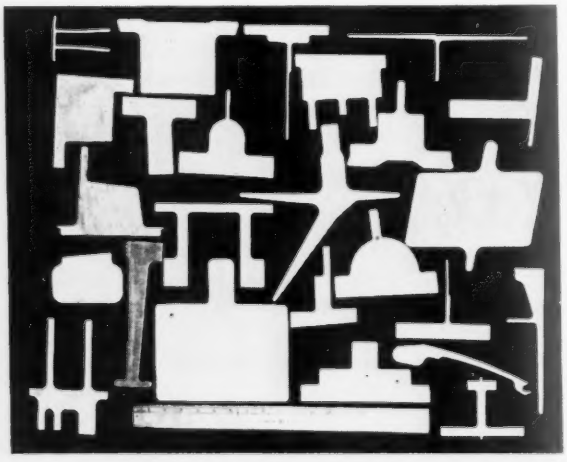


FIG. 7. Extruded shapes that are typical of the extrusions made for aircraft.

However, the direction of metal flow corresponds closely to the direction of applied major stresses when the extrusion is used as an aircraft wing spar. Thus, no impairment to permissible design values is indicated.

At the rear of an extrusion produced by the direct method, there may be found two abnormal conditions if the extrusion process is carried beyond what is considered good practice. Most extrusion plants employ some means to inspect each piece for such abnormalities or defective conditions if the application is such that it requires complete freedom. For aluminum alloys, this is done by deep caustic etching of slices from the rear portion of each extrusion. One of these conditions, often termed "the extrusion defect," is a conical-shaped cavity increasing in diameter toward the rear. It has its source in transverse flow across the face of the dummy block, and its final form results in a cavity formed by a pulling away from the center of the block. Its control is rather simple because anything that slows down the transverse flow on the dummy block minimizes the defect to the point of negligible effect. The other abnormality, which has been called "the ring condition," may occur earlier in the extrusion, and its control is more difficult. Its source lies in the surface of the ingot and in the flow pattern developed by extrusion. If the ingot surface contains oxide inclusions or other defects to a considerable depth, the ring condition may be found before half of the metal is extruded, but normally it is confined to the extreme rear. As ingots and sections become larger, more rear-end discard on a percentage basis of the ingot length is required to remove completely the undesirable conditions.

A broken surface normally will occur first at sharp corners or radii but, in more severe cases, can cover the entire surface of the extrusion. The breaks result from excessive extrusion speed for the alloy under the temperature conditions existing.

Die lines and pickup are two other typical surface defects associated with the extrusion process. The die lines are caused by adherence of metal to the die or, in the more usual case, scratches in the die bearing resulting from hard particles being extruded through the opening. They are not particularly troublesome with large aircraft sections. For pickup the oxide formed may agglomerate into fair-sized particles as it collects and finally may adhere to the surface of the extrusion. This type of defect is particularly troublesome with the stronger alloys when it is necessary to use relatively high extrusion temperatures. Thorough cleaning of the die bearing and watercooling of the extrusion tools minimize the occurrence of pickup.

Of primary importance for the production of high-quality large aircraft extrusions is the type of ingot stock available. Good ingots must be sound and have uniform, fine-grained structure free of porosity, segregation, and surface defects. Fortunately, ingot casting has kept in step with the procurement of larger extrusion presses and will not represent any deterrent to their use.

Special Products

In addition to the normal types of extrusions, certain specialties have been mentioned, and these present problems of fabrication far beyond their proportionate share. The advent of larger extrusion presses will create the possibility of producing many more of such commodities and present the opportunity to exercise the utmost ingenuity in creating useful things.

Stepped extrusions have been discussed because they represent a typical large-press product. A common type of stepped extrusion may be seen in Fig. 5.

Integrally rib-stiffened aircraft wing panels have been the cause of much experimentation with the extrusion process. Several schemes have been tried with good results. The extrusion part of the problem is relatively simple, but straightening to the necessary flatness presents more difficulty. With present presses, the limit for such extrusions is about 27 in. wide, but, with the installation of the 14,000-ton extrusion press, it is conservatively estimated that this can be increased to 34 in. Typical sections are shown in Fig. 6.

A group of typical aircraft extrusions illustrated in Fig. 7 shows several very large sections now produced. Larger presses will not only add to the size of these sections but will also contribute to the intricacy of design, with higher pressures available for cylinder sizes now in use. In addition, the larger presses should assist in the production of high-quality forging stock in sizes beyond present availability and should present the opportunity for employing various combinations of extrusion and forging to produce new materials.

The extrusion process, when conducted with proper controls produces a product of high quality and good mechanical properties. Sections may be simple or complicated, balanced or unbalanced, symmetrical or nonsymmetrical, solid or hollow, and the process comes close to satisfying all the whims and fancies of the design engineer.

Sherman M. Fairchild Publication Fund Papers

No.		Member Price	Nonmember Price
FF-7	Natural Flight and Related Aeronautics—James L. G. Fitz Patrick.	$2.65	$3.50
FF-6	Wetted Length and Center of Pressure of Vee-Step Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
FF-5	Symposium on Standardization in Technical Information Services for Government Contractors.	$1.00	$1.00
FF-4	Finite Deflections of Curved Sandwich Plates and Sandwich Cylinders—F. K. Teichmann and Chi-Teh Wang.	$0.50	$0.85
FF-3	The Penetration of a Fluid Surface by a Wedge—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
FF-2	A Study of the Flow, Pressures, and Loads Pertaining to Prismatic Vee-Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
AHS-1	Helicopter Flight Research at NACA, Langley—Jack P. Reeder.	$0.35	$0.75
286	Linearized Treatment of Supersonic Flow Through Axi-Symmetric Ducts with Prescribed Wall Contours—Charles E. Mack, Jr., and Ignace I. Kolodner.	$0.75	$1.25
244	Wetted Area and Center of Pressure of Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	$0.75	$1.00
229	Wave Profile of a Vee-Planing Surface, Including Test Data on a 30° Deadrise Surface—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
170	Wave Contours in the Wake of a 10° Deadrise Planing Surface—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
169	The Discontinuous Fluid Flow Past an Immersed Wedge—Experimental Towing Tank, Stevens Institute of Technology.	$0.75	$1.00
168	Wave Contours in the Wake of a 20° Deadrise Planing Surface—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
167	On the Pressure Distribution for a Wedge Penetrating a Fluid Surface—Experimental Towing Tank, Stevens Institute of Technology.	$0.75	$1.00
166	An Analysis of the Fluid Flow in the Spray Root and Wake Regions of Flat Planing Surfaces—Experimental Towing Tank, Stevens Institute of Technology.	$1.20	$1.60
165	Theory and Practice of Sandwich Construction in Aircraft (A Symposium).	$1.85	$2.50
164	Applications of the Theory of Free Molecule Flow to Aeronautics—Holt Ashley.	$1.15	$1.50
106	Measurement of Ambient Air Temperature in Flight—W. Lavern Howland.	$0.35	$0.50
105	An Evaluation of the Importance of Fatigue Phenomena in Aircraft—C. R. Strang, L. R. Jackson, L. F. McBrearty, R. V. Rhode, and R. L. Schleicher.	$0.80	$1.10
104	Tensor Analysis of Aircraft Structural Vibration—Charles E. Mack, Jr.	$1.85	$2.50
102	Electrical Resistance Strain Gages Applied to Wind-Tunnel Balances—Elmer C. Lundquist.	$0.60	$0.80
101	Introduction to Shock Wave Theory—J. G. Coffin.	$2.65	$3.50
100	Blade Pitching Moments of a Two-Bladed Rotor—R. W. Allen.	$0.75	$1.00
126	External Sound Levels of Aircraft—R. L. Field, T. M. Edwards, Pell Kangas, and G. L. Pigman.	$0.75	$1.00

Papers should be ordered by number from:

Publications Department, Institute of the Aeronautical Sciences, Inc.

2 East 64th Street, New York 21, N.Y.

Combat-Ready Aircraft

COL. B. A. SCHRIEVER*
United States Air Force

Introduction

Last year a study was made which examined critically both Air Force organization and established procedures in their relation to achieving combat readiness in aircraft weapons. Although complexity of equipments was not considered per se, the effect of organization and procedures on the nature of weapons is considerable and will be highlighted as I proved. In fact, without the proper research and development organization and procedures, it is wishful thinking to believe that real control over complexity can be achieved. A policy statement alone, without effective organization and procedures to back it, will have about the same effect as that old directive that there be no more forced landings.

The problem was to study Air Force organization and procedures which govern the development and procurement of aircraft to determine if changes could be effected which would improve the combat readiness of aircraft in tactical units.

It is obvious that the complete answer cannot be found in organization and procedures alone. There were, nevertheless, certain organizational and procedural factors that appeared worthy of overhaul to improve our ability to attain combat readiness in our aircraft.

Basic Functions in Creating Combat Readiness

Now what do we mean by a combat-ready aircraft? (See Chart 1.) And next, what conditions achieve combat readiness? (See Chart 2.) Often in the past we have failed to satisfy fully these conditions. Many examples could be cited, examples of failure which have compromised the effectiveness of the Air Force. These problems cannot be eliminated entirely, but their frequency and their magnitude can be reduced. To understand how, we must consider the three basic functions in creating combat-ready aircraft and their influence and interaction throughout the entire life of the aircraft. These are the operational function, the technical function, and the logistical function.

The operational function is the responsibility of the operational agencies within the Air Staff and of the operational commands that are concerned with defining

COMBAT READY Aircraft
-is a Tactically Suitable Complete Weapon...
including
1 THE AIRFRAME with its PROPULSION SYSTEM
2 THE AIRBORNE COMPONENT SYSTEMS
3 GROUND SUPPORT EQUIPMENT
4 SPARES and SUPPORTING SUPPLIES
5 PERSONNEL TRAINED in its OPERATION and MAINTENANCE

Chart 1.

Chart 2.

Presented to the Washington Section, I.A.S., Washington, D.C., October 7, 1952.

* Assistant for Development Planning, DCS/Development, Department of the Air Force.

the task that new weapons are to perform and using these new weapons to perform that task. *The technical function* is the responsibility of the engineers and scientists of the Air Force research and development family, both in the Air Staff and in the command, who are concerned with evaluating the ability of our technology to design a weapon to perform this task, determining the time required to perfect the weapon, and guarding continually the quality of the weapon. *The logistical function* is the responsibility of materiel people, in the field materiel agencies and in the Air Staff, who are concerned with obtaining sufficient quantities of the new weapon and providing all the necessities for continued use of the weapon.

Each of the three functions has a continuing responsibility and interest throughout the life span of an aircraft. The five important phases in the life span are (a) the establishment of qualitative requirements, (b) development, (c) testing, (d) procurement, and (e) service life.

Initially, when *qualitative requirements* are decided upon, the operational function must be to define the anticipated task; the technical function is to determine whether the task is within our technological capability; the logistical function is concerned with the demands of the new weapon upon our logistic capability.

During *development*, the technical function is to mate scientific progress with future operational demands in order to design the best weapon; the operational and logistical functions are to guard the usability of the future weapon against compromise by technical complexity.

During *tests*, the technical function must be to prove the excellence of the product; the logistical function is to prepare for mass production; the operational function is to learn how well the new weapon will do the new job.

In *production*, the logistical function is to exert the greatest demands in producing the new weapon and supporting equipment in large quantity; the technical function is to complete the remedies needed for the failings indicated in the tests; the operational function is to demand the training of people and all other preparations required to put the new weapon into use.

Finally, during *in-service life*, the operational function is not only to use the weapon but constantly to enlarge its task; the technical function is to devise methods for the weapon to accomplish these new tasks and similarly to continue to guard the weapon's qualitative excellence. The logistical function calls for adaptation of the weapon to the expanded tasks, as well as for providing the things necessary for continued use of the weapon.

Thus, we find that each of the three functions, operational, technical, and logistical, demands constant attention throughout the life span of the aircraft.

Now, with this background—namely, (1) past lack of combat readiness which has often reduced Air Force effectiveness; (2) the conditions necessary for combat readiness as indicated on Chart 2; and (3) the influence and interaction of the operational, technical, and logistical functions during every phase in the life of the aircraft—it is now possible to examine how well Air Force organization and procedures were geared to achieve combat-ready aircraft.

Analysis of Organization and Procedures

The analysis of organization and procedures started with the conception of the weapons system during the qualitative-requirements phase, continued to the birth of the aircraft in the development phase, and followed the aircraft through procurement and testing and, finally, to maturity in useful in-service life.

Qualitative-Requirements Phase

Let us consider first the qualitative-requirements phase. It was found that since the war aircraft during development and production were subject to constant changes in military characteristics. Examples are changes in bomb-load capability, armament configuration, and aerodynamic performance requirements. In one case, even the mission was changed.

It was clear that our qualitative requirements during this period were based primarily on relatively short-term considerations such as (1) current tactical deficiencies, (2) current technical deficiencies, and (3) minor extensions of current tactical concepts.

Inadequate advance planning works harm in three ways: (1) it provokes extensive changes to the aircraft; (2) it necessitates substitution; and (3) the development of components for the new task must be initiated long after the aircraft has been designed, and delays in the testing of the new weapon as a complete system also result.

As a result, qualitative requirements based on short-term factors had an adverse effect on two of the conditions necessary for combat readiness.

(1) *Tactical Suitability.*—Constant modification or resoling of existing types cannot keep abreast of the "state of the art."

(2) *Completeness as a Weapon.*—Changes in military characteristics during development and procurement render a coordinated component and aircraft development program difficult.

Qualitative requirements, then, must also include long-term considerations such as military strategy, Air Force missions and objectives, probable enemy capability, technological potential, and the development time cycle. Only by such a balance of immediate and long-term factors is the way opened to the introduction of properly time-phased new developments to go with healthy growth potential to provide a modern, economical "force-in-being."

Experience has shown that it is difficult for Air Force requirements people to give adequate consideration to the longer-term factors or to take an analytical approach to the problem. This is not their fault. Requirements is constantly under the guns of the operational commanders, and, as a result, by far the largest

percentage of their energies is devoted to the more immediate problems associated with the force-in-being. To correct this situation, the Office of Development Planning was established in the recent Air Force reorganization of research and development. It concerns itself primarily with tomorrow's Air Force, and its aim is to reinforce military judgment with an analytical base that will improve the prospects of placing money on the weapons that will result in the most effective future Air Force. An analytical base for requirements similarly adds greater stability to development programs, since proponents for changes in military characteristics which are based on opinion, prejudice, and intuition will have a much rougher road to travel than in the past before obtaining approval.

You may wonder how the establishment of qualitative requirements affects complexity of equipment. This can best be pointed out by giving as an example a component system, since our major complexity problems have been in this area, particularly in electronics.

Let us look at our bombing-system development. At the beginning of the last war, the Norden bombsight, which weighed 75 lbs. and had no vacuum tubes was used. However, it solved only the daylight visual bombing problem and required a long straight and level bomb run. This represents the ultimate in simplicity, but it is not wanted today.

The first radar sight, APQ 13, was introduced in 1943 and weighed about 630 lbs, and contained 78 vacuum tubes. This system permitted bombing at night and through overcast but contained no navigation capability and had other operational limitations.

After the APQ 13 came the APQ 24, and now there is the K-1 system. Recent congressional hearings disclosed that the K-1 weighs 1,700 lbs. and contains 365 vacuum tubes. It is true that the K-1 system contains a combination of the most desirable operational modes. For example, the system coordinates in one presentation the optics and radar indication. The inclusion of this mode greatly increased the computer accuracy required to exploit completely the inherently better resolution of the optics. A large measure of the increased complexity of the K-series results from this.

Simplification of this system without loss of true operational capability can come only from enlightened high-level guidance that can properly adjudge the operational value of this optical mode. This problem obviously extends beyond the sphere of the design engineer.

The point is not that the K-1 is not the right system, but rather it illustrates how qualitative requirements influence complexity. It is necessary to review carefully the actual requirements of our bombing system and determine, for example, at what stage a particular operational mode can be sacrificed or what level of accuracy should be attempted in light of atomic weapons availability in order to maximize our real operational capability.

At some point in the long chain of events, real capability may become limited by the inability to maintain the complex instruments rather than by the lack of the operational capabilities they were designed to overcome. With the increasing cost of delivering atomic weapons, reliability of the armament equipment becomes even more acutely important. Fundamental to obtaining high system reliability is system simplicity. A degree of simplicity can be gained only by eliminating operational modes that are of questionable value and restricting the accuracy demands made of the system to that which produces the most economical total strategic capability. The latter can be accomplished only by a planning group operating at air staff level which can consider and integrate all factors pertinent to the problem from national policy to technology. Only at such a level can any possible trade-off, such as bomb size for accuracy, be established to maximize our striking power. In other words, the problem of equipment complexity is complex in itself.

Development Phase

Next, let us take the development phase. The development organization is responsible for the technical function, including the task of developing a complete weapons system. Completeness of the weapon is one of the conditions for combat readiness which is very difficult to achieve. The effect of constant changes in qualitative requirements on this condition has already been described. The internal organization of the technical agency can similarly exert influence on the timely achievement of the complete weapon. Chart 3 illustrates some of the major component systems required for a complete bomber weapons system.

Chart 3 illustrates several important points.

(1) Development lead time varies for the several component systems.

(2) Component systems require test before installation in the air frame.

(3) Certain component systems require longer development and test periods than the air frame itself.

It is obvious that to have all the pieces mesh takes a degree of luck. Also, it requires weapons-system planning, budgeting, and control. In the past, there was not sufficient organization to do this most effectively.

The Air Force internal research and development organization, as it was, is also portrayed on Chart 3.

The requirement for a new weapon, although stated as a complete system, tended to lose its identity as such. This condition arose because of the channelization of scientific effort into specific technical areas and led to various component systems becoming ends in themselves. In the field development agency, the weapons-system requirement lost its identity further as the various components fell under the jurisdiction of laboratory organizations, each competing for personnel, facilities, and funds to develop its specific equipment. Although a coordinating mechanism existed, it lacked the teeth to be really effective.

How this organization problem has been remedied is indicated on Chart 4. In the Air Staff and also in the

field development agency, complete weapons-system control has been instituted above the organizations specializing in individual components. This management level above the technical divisions and technical laboratories has responsibility and authority to plan, budget, program, and control the research and development effort of the Air Force. (See Chart 5.)

Now, how will this organizational change contribute to the problem of complexity? First, remember that all development does not stem from qualitative requirements. Much of it is internally generated within the laboratories, and this is as it should be. It is human nature for the project engineer to want his black box to have the least possible instrument error. However, reducing instrument error usually leads to greater complexity, but it does not necessarily follow that the operational capability of the weapons system of which it is a part is significantly improved. I do not believe this has led to an unusual increase in complexity, and, under any circumstances, the extent to which it has would be difficult to evaluate.

With research and development management now oriented to a weapons-system concept, the desired "black-box" performance can be more realistically geared to the operational mission the system must perform. In addition to contributing to combat readiness, the reorganization is a step in the right direction in combating unnecessary complexity.

Study of combat-ready aircraft did not stop with the consideration of qualitative requirements and research and development management but also included procedures governing the important timewise interrelation of development, production, testing, and in-service. However, past procedures, as well as those now in effect, have only minor influence on the problem of complexity. Therefore, they will not be discussed.

Complexity

Mechanical complexity increased rapidly between World War I and World War II. Retractable landing gears, landing flaps, and controllable-pitch propellers now used on all modern aircraft, even on commercial aircraft, were only a short time ago complicated, heavy, costly, and unreliable. Many experts considered them unnecessary and undesirable complications.

Every new device goes through a period of development and "debugging" before it is a proved article. During this period, it usually gains a bad reputation, and unless it is really useful stands little chance of surviving. It seems historically true that the simple things that are used in aviation today were the complicated things of yesterday.

The question is not whether equipment is complicated. Actually, in this era of high-speed flight, electronics, and atomic weapons, it has to be complicated to do its job. The real question is whether it is unnecessarily complicated. The answer to this question must be related to the mission that must be performed.

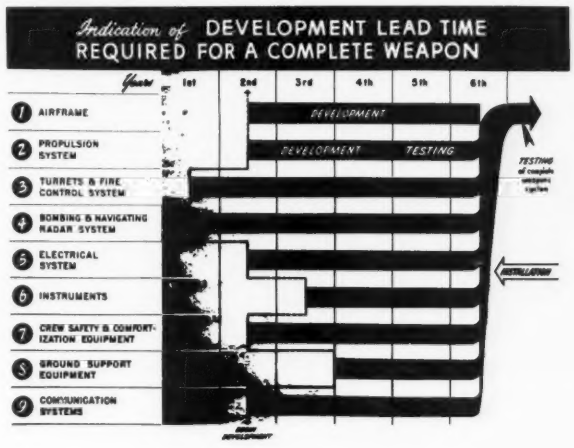


Chart 3.

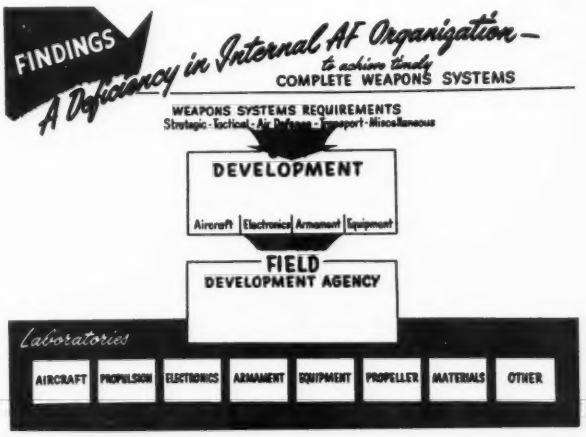


Chart 4.

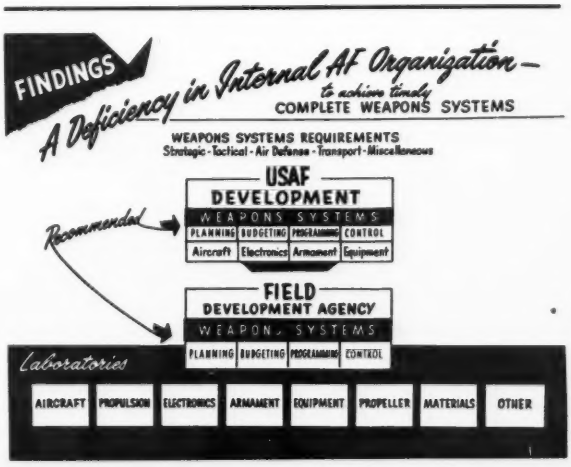


Chart 5.

The Air Force has a most important responsibility to the Nation. Its strategic air arm is generally conceded to be the major deterrent to a general war, and, should this fail and a general war occur, the Air Force is charged with the air defense of the United States. With these responsibilities it simply cannot afford to have second-best equipment.

If more were known of what transpires behind the Iron Curtain, perhaps U.S. Air Force equipment would not have to be built to the limit that the state of the art will permit. What is known indicates that Russian aircraft are good and that their methods of construction and production are essentially equivalent to those of the United States. Therefore, the question of whether equipments are unnecessarily complicated is an extremely difficult one to answer, and the answer does not lie in platitudes and generalities.

As mentioned previously, the Air Force has established the Office of Development Planning in the Air Staff. This office will provide the means whereby decisions on qualitative requirements can be made on a sound basis. This is not a path to simplicity, but it is a step that should eliminate to a large degree unnecessary complication of equipment. Also contributing is the management philosophy in the Air Research and Development Command now approximately 2 years old. This philosophy embraces management of research and development programs by complete weapons systems rather than by individual components. The benefits of such management as it pertains to complexity have been covered already.

Conclusion

In conclusion, it is Air Force policy to utilize all information to analyze the job it has to do, determine its requirements, and attain the best possible equipment necessary to do the job. This equipment *must* be capable of accomplishing its mission. In addition, it must be economical to produce and as simple to operate and maintain as possible. In the writer's opinion, the Air Force has been doing a good job in meeting its complicated obligation to the Nation and will strive to do an even better job, thinking always in terms of effectiveness, efficiency, and economy.

Special I.A.S. Publications

	Member Rate	Nonmember Rate
Aeronautical Engineering Index – 1951	$ 3.00	$ 5.00*
1950	2.50	4.00*
1949, 1948, 1947	2.00	3.00*
Second International Aeronautical Conference Proceedings	15.00	17.50*
First Convertible Aircraft Congress Proceedings	3.00	5.00*
Fifteenth Wright Brothers Lecture—The Experimental Approach to Aircraft Structural Research, P. B. Walker (Reprinted from the March, 1952, and April, 1952, JOURNAL OF THE AERONAUTICAL SCIENCES)	1.00	1.50
The Earth's Atmosphere, H. E. Roberts, including 20- by 16-in. colored chart (Reprinted from the October, 1949, AERONAUTICAL ENGINEERING REVIEW)	0.65	1.00

*Add $1.00 for orders outside the U.S.A.

These may be obtained by writing to

Publications Department, Institute of the Aeronautical Sciences, Inc., 2 E. 64th St., New York 21, N.Y.

Laboratory Simulation of Aerodynamic Heating for Transient Temperature Measurements*

L. H. Wilson† and J. B. Falk‡
McDonnell Aircraft Corporation

Abstract

This paper introduces a method of determining transient temperature distributions in complex heat-flow paths under conditions of aerodynamic heating. The method consists of simulating the aerodynamic heating phenomenon by circulating a suitable fluid at elevated temperature past models of sections under consideration, the fluid having been preheated to a specific temperature and flowing by forced convection with an appropriate velocity. The apparatus and instrumentation used in certain tests are described, and limited test results are presented.

Symbols

C_p = fluid specific heat, B.t.u. lb.$^{-1}$ °F.$^{-1}$
D_e = equivalent diameter = 4 × flow area/wetted perimeter
h = convective heat transfer coefficient, B.t.u. hr.$^{-1}$ ft.$^{-2}$ °F.$^{-1}$
K = fluid thermal conductivity, B.t.u. hr.$^{-1}$ ft.$^{-1}$ °F.$^{-1}$
V = fluid bulk velocity, ft. hr.$^{-1}$
ρ = fluid density, lbs. per cu.ft.
μ = fluid viscosity, lb. ft.$^{-1}$ hr.$^{-1}$
L = distance from nose of body of revolution, ft.

Introduction

In the field of high-speed missile design, the problem of transient temperature distribution determinations has become of paramount importance, with regard to both maximum temperatures experienced during flight and localized thermal stresses induced in structural members due to transient temperature gradients. The technical literature contains much information concerning the boundary-layer characteristics necessary to determine skin friction and heat transfer on the surface of high-speed missiles. With such information available, the transient adiabatic wall temperatures and equilibrium temperatures may be calculated; however, when complex internal heat-flow paths and indeterminate thermal resistances are encountered, the designer must resort to experimental methods. Wind-tunnel testing time is expensive, and few (if any) facilities are capable of reproducing the aerodynamic heating conditions experienced in flight trajectories of high-speed missiles.

* Work supported by the Bureau of Ordnance, U.S. Navy-under Contract Nord 11329, Bumblebee Project, and performed in association with the Bendix Products Division and the Applied Physics Laboratory.

† Aerodynamics Department, Missile Engineering Division; also, Assistant Professor of Mechanical Engineering, Washington University, St. Louis.

‡ Aerodynamics Department, Missile Engineering Division.

The Basic Analogy

Convective heat-transfer coefficients have been determined from flight-test and wind-tunnel-test data correlations, and, thus, temperature transients outside the influence of thermal sinks can be calculated. For parabolic bodies of revolution of high fineness ratios, the heat-transfer data correlation of reference 1 is recommended.

The heat-transfer data correlation for turbulent flow over the outside of a body of revolution is

$$\frac{hL}{K} = 0.0296 \left(\frac{VL\rho}{\mu}\right)^{0.8} \left(\frac{\mu C_p}{K}\right)^{1/3} \qquad (1)$$

The analogy reproduces the convective coefficient calculated above by flowing a suitable fluid at an appropriate velocity past the section under consideration. Assuming the fluid flows through a rectangular duct, the convection coefficient may be determined by Colburn's equation for pipe flow (turbulent flow)

$$\frac{hD_e}{K} = 0.023 \left(\frac{VD_e\rho}{\mu}\right)^{0.8} \left(\frac{\mu C_p}{K}\right)^{1/3} \qquad (2)$$

If the fluid film temperature (average of wall and fluid bulk) is made equal to the adiabatic wall temperature and the convective heat-transfer coefficient for the heating fluid is made equal to the coefficient for air, the aerodynamic heating phenomenon is completely simulated. It has been found that the fluid velocities are of the order of magnitude of 0.1 per cent of the air velocities, depending, of course, on fluid-flow channel size, thermal properties of the fluid, missile altitude, and body station of interest.

As a missile is accelerated and changes altitude, the thermal convection coefficient of course varies. A skin-temperature history may be calculated by a stepwise procedure when the trajectory is divided into small increments. By proper preset constant values of fluid bulk temperature and convection coefficient, the analog approximates this temperature-time curve with a constant heating-fluid flow rate for many practical cases. The convection coefficient is preset by adjustment of flow rate and/or stream turbulence for a given flow channel.

The analog described herein is based upon the valid premise that, if the boundary conditions for heat input to an appropriate test specimen are properly reproduced, the aerodynamic heating phenomenon has been simulated. Then, measured temperatures at any

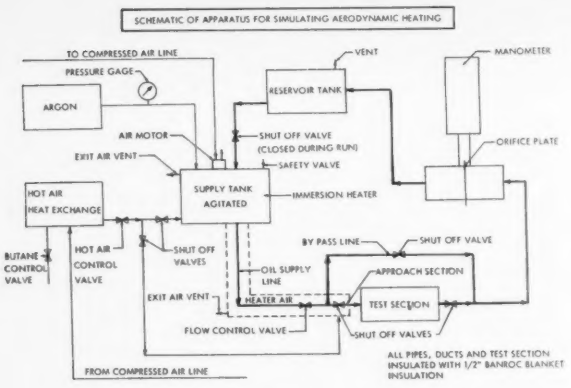


FIG. 1

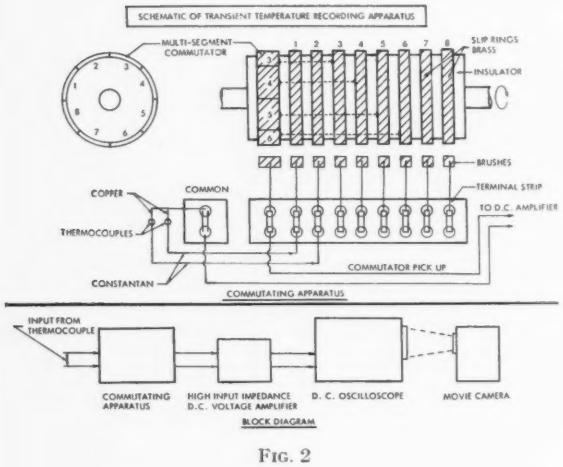


FIG. 2

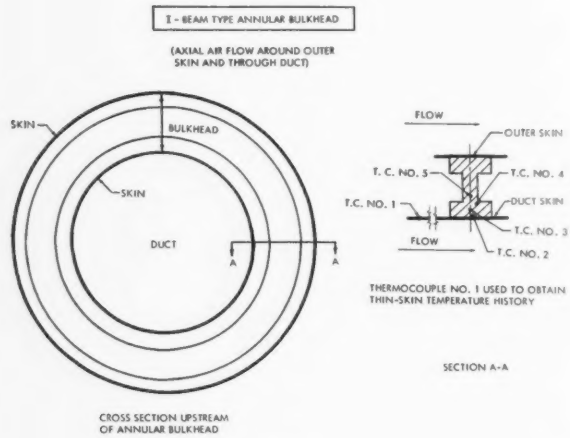


FIG. 3

point in the test specimen will be identical with those encountered during flight under the represented conditions of aerodynamic heating. The accuracy of the results thus depend only upon the accuracy of the temperature history duplication and on the faithfulness with which the test specimen duplicates the prototype.

DISCUSSION OF TEST SETUP

The basic apparatus components necessary for simulation of aerodynamic heating are shown schematically in Fig. 1. The operating fluid is preheated in the supply tank by means of immersion type electric heaters and agitated by means of an air-motor-driven stirrer. After thermal stabilization, the supply tank is pressurized with a chemically inert gas (argon was used in reported tests) to produce the potential for flow. A safety valve should be provided to limit the system pressure to a value consistent with the high-temperature operation. In order to control temperature drop through the system and to heat the operating fluid rapidly, a heat exchanger operated from a butane tank is used to heat low-pressure air to be ducted to chambers housing the oil supply line, supply tank, approach, and test sections. The operating fluid flow is regulated by means of a gate-type control valve and is metered by means of an orifice-type flowmeter. A by-pass line is provided to permit establishment of the flow to a predetermined value. The operating fluid is collected in a reservoir and is emptied into the supply tank at the conclusion of a test.

In many tests it is desirable to record continuously several temperatures. Standard instrumentation was found unsatisfactory for these tests, and therefore an apparatus of the type shown schematically in Fig. 2 was devised. The apparatus consists of a thermocouple commutator, a high impedance d.c. thermocouple e.m.f. amplifier, a d.c. oscilloscope, and a high-speed movie camera. With this apparatus, any number of temperatures may be simultaneously recorded (limited only by the number of commutator segments) with an accuracy approximately equal to that of a portable precision potentiometer.

TEST PROCEDURE AND RESULTS OF TYPICAL TEST

The "hot-oil" analogy was conceived and utilized to determine transient temperature distributions for various critical structural components of a supersonic missile that operates under conditions for which Eq. (1) is applicable. An example of testing procedure with test results pertinent to establishing the validity of the analogy is discussed.

Consider a simple I-beam type annular bulkhead for a ducted aerodynamic body such as is shown in Fig. 3. For simplicity, assume that the heat-input function from the ducted side of the body is identical to the heat-input function from the outer side; thus, the temperature distribution in the section is symmetrical and can be simulated by insulating the member at its midpoint. Consider further that this bulkhead is joined to a thin skin, thus effecting a skin-to-bulkhead contact resistance that is indeterminate. The problem is to determine temperature histories for the bulkhead and skin for an assumed flight trajectory.

The temperature history for the body skin outside the influence of the bulkhead was calculated for flight conditions for a given trajectory by use of Eq. (1) and a

suitable temperature recovery factor. A reasonable oil-flow channel was established, and, as a first trial, the oil bulk temperature was assumed equal to the adiabatic wall temperature of the air, and the oil convective heat-transfer coefficient was assumed equal to a timewise average of the air convective heat-transfer coefficients throughout the trajectory. For these calculated conditions, the skin-temperature history was computed. If the two temperature histories did not agree satisfactorily, adjustments were made for the oil-test heat-transfer coefficient and bulk temperature until best agreement was obtained. The oil-flow velocity was then calculated with Eq. (2). The results of these calculations yielded an oil flow to be used in the test; however, the accuracy of duplication of predicted flight temperature histories depends upon several factors—namely:

(1) Accuracy of knowledge of thermal properties of heating fluid and their variation with temperature.

(2) Magnitude of oil-bulk temperature drop as fluid passes through test section (minimized by proper test section flow channel choice).

(3) Accuracy of estimation of effective film temperature (average between fluid bulk and test section wall temperatures) at which thermal properties should be evaluated.

(4) Degree of surface deposits on test section surface.

(5) Time lag between initial by-pass line closure and velocity stabilization in test section.

Because of the above uncertainties, some successive approximation procedure was necessary in order to obtain maximum agreement between measured temperatures and calculated flight temperatures.

Fig. 4 shows the relative correlation for the described test after four cut-and-try runs. The maximum deviation for this test was about 2 per cent, all other tests having about the same deviation.

The boundary conditions of heat input to the test specimen were thus shown to be accurately represented. Transient temperature measurements obtained simultaneously at several critical locations inside the test specimen, therefore, were considered as valid and were used for structural design purposes.

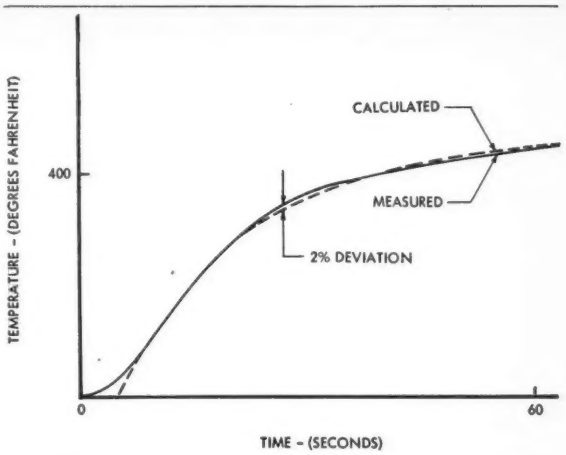


FIG. 4. Thin-skin temperature history for annular bulkhead.

CONCLUSIONS

Although this method for simulating aerodynamic heating has not been thoroughly documented, enough evidence of its applicability has been obtained to ensure that it can be a valuable adjunct to current testing procedures, both for design purposes and as a research tool.

The example cited was for a body with a thin skin which would have no appreciable temperature gradient through the skin. It is felt that the applicability of the method is not restricted to such geometries. Transient temperatures can be calculated for a fictitious skin assumed to have the same heat-input function as a body of any geometry, and the model may be set up for test measurements with the thin skin insulated from the main body. If the thermal and physical properties of the insulated thin skin are identical with those used in calculation and if the calculated temperature history of the fictitious skin is reproduced, measurements of temperatures at any point in the model are valid reproductions of those that would be experienced in flight.

These tests were conducted using an oil that restricted the maximum operating temperatures; however, other fluids with higher critical operating temperatures could be used for simulation of aerodynamic heating for future design.

REFERENCE

[1] Colburn, A. P., *A Method Correlating Forced Convection Heat Transfer Data and A Comparison with Fluid Friction*, Transactions, American Institute of Chemical Engineering, Vol. XXIV, pp. 174–210, 1933.

Automatic Reduction of Wind-Tunnel Data

V. S. HANEMAN* L. L. RAUCH†
R. J. LEITE‡ U. A. COTECCHIA‡

Wright Air Development Center
and
University of Michigan

ABSTRACT

An analog computer has been developed to eliminate the present costly, time-consuming process of manual data reduction. This computer will take the output of transducers, operate on them, correct for tares, position, etc., and produce a d.c. voltage proportional to the desired quantities or their coefficients. The main features include: immediate computation and presentation of results; ability to follow dynamic phenomena up to 500 cycles per sec.; an accuracy at least as high as the average transducer; self-balancing and checking of various components; calculation of a "least squares" fitting to test data; ability to integrate pressure data over a model for force; and low-cost construction.

(I) INTRODUCTION

A METHOD OF AUTOMATIC REDUCTION of wind-tunnel data has been developed by the Department of Aeronautical Engineering at the University of Michigan. This work has been sponsored by the Computation Research Section, Flight Research Laboratory, Wright Air Development Center, under contract AF33(038) 20806, with the Engineering Research Institute of the University. The results of this project are applicable to many other fields of testing and data handling.

The work on this project was performed on the Michigan campus by the authors from February, 1951, through June, 1952. The method of data reduction used relies on known analog computation techniques with particular attention paid to accuracy, reliability, and ease of maintenance and operation.

Missile and aircraft development has been delayed by the unfulfilled requirement for an automatic data reduction system. This system presents the finished results of wind-tunnel tests during, and directly after, the conducting of tests.

One of the largest problems in wind-tunnel testing is the time consumed in converting raw test data into a usable form. At present, data are handled two and three times before the end result is obtained. Data are recorded, transcribed, and computed either manually or by IBM equipment, and each step is costly in time and money.

Many times, extremely lengthy tunnel test programs are conducted to obtain optimum missile or aircraft configurations. These programs could be reduced considerably if the data produced could be analyzed immediately and nonproductive trends discarded.

The occurrence of poor test runs or unusual results is an always present hazard. Discovery of these variations cannot usually be made until the data are in recognizable form. Verification tests must then be rescheduled at some later time, producing long time delays between initiation and conclusion of an investigation.

This computer has been developed to help eliminate these difficulties. The use of analog techniques allows presentation of the computed results immediately. The computer will take the output of transducers, operate on them, correct for tares, position, etc., and produce a d.c. voltage. This voltage is proportional to the desired quantities—i.e., force, moment, pressure, their coefficients, and/or center of pressure.

Overall, this unit allows immediate evaluation of results and reduces the cost in time, personnel, and equipment for obtaining completed test results.

(II) ERROR ANALYSIS

In the design of a computational device such as this, it is necessary to make an error analysis of the entire facility. The sources of error which require attention start with the basic theory of the facility and end with the use of the completed data.

For example, three basic items should be checked in a simulation facility. These items are the basic correlation, the effects of nonperfect simulation, and the method of measuring the parameters of the system. The basic correlation between the physical situation and a perfect simulation system must be established; and, in addition, the degree of accuracy which may be obtained based on fundamental theory must be determined. Consideration of the effects of nonperfect simulation should include the problems of local variations of parameters, nonconstant coefficients, and, in general, all the nonlinearities that may have a bearing on the system. This assessment will help in evaluating the validity of certain linearizing assumptions in addition to determining their error component. Errors introduced by the measuring devices—i.e., transducers,

* Captain, U.S.A.F., Flight Research Laboratory, W.A.D.C., Wright-Patterson Air Force Base, Ohio. Formerly, Research Engineer, University of Michigan.

† Associate Professor of Aeronautical Engineering, University of Michigan, Ann Arbor, Mich.

‡ Research Associate, Engineering Research Institute, University of Michigan, Ann Arbor, Mich.

end instruments, and sensing units—and the method of application of these instruments to the system will limit the maximum accuracy obtainable. This third item must not be slighted since it includes the selection and use of one of the most critical sections of an integrated system.

The use of the information gained from an entire facility should be carefully scrutinized. If the required accuracy is equal to or less than that indicated by the above investigation, there remains but one problem. That problem is to transform the output from the measuring section to the required form. From the knowledge gained, an evaluation of the computing systems available can be made and one of these selected to provide a balanced system. There is no requirement to compute final data to ten significant places when the input data are good to but three or when the final data need be used only to two- or three-place accuracy.

If it is discovered that the accuracy of final data required is greater than that obtainable from the facility, then a re-evaluation of either the desired accuracy or the type facility must take place. In either case, the re-evaluation will yield the information necessary to select a computational system.

(III) Application

The system presented in this paper evolved from an error analysis similar to that described in Part (II) above. The work yielded systems accuracies not much better than 10 per cent.

This meant that any precision in computation greater than 1 per cent would be more than satisfactory. A 1 per cent error in the computation would yield an overall accuracy of 10.05 per cent. Even if the system accuracy were an order of magnitude better than 10 per cent, the additional error due to computation would only be 0.4 per cent.

From this accuracy data and the requirement that the computation be accomplished with no time lag, it was decided to use analog techniques in the computation.

The computer to be developed must receive the output from transducers or sensing units and yield forces or coefficients. The position of this computer in relation to other units of the system is shown schematically in Fig. 1. The required accuracy was 1 per cent; the design accuracy was a hopeful 0.1 per cent.

The general force problem to be solved by this computer is the solution of the least squares straight line fitting of n test points. This arises from the use of strain gages as sensing elements attached to a cantilever beam. This beam is referred to as the sting. The sting (beam) holds the model under test and is aerodynamically shielded so that all forces imposed on the sting are due to the model. The gage outputs are proportional to the moments existing at the gage locations. The moment at any point along the beam is given by the equation

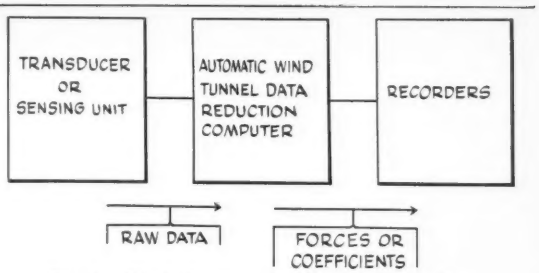


Fig. 1. Block diagram of wind-tunnel data flow.

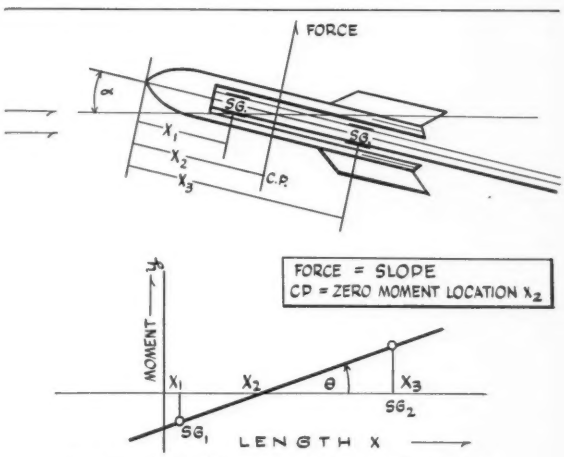


Fig. 2. Typical force-moment measuring system.

$$M = a + bx$$

where

M = moment at any point
a = moment at the x coordinate origin
b = normal force
x = distance along the beam with arbitrary origin

The desired quantities of this computation are force and center of pressure (location of the point of application of the force). These quantities are represented by b and a/b of the above equation, as shown in Fig. 2.

The problem becomes complicated if more than two strain-gage locations are used. This requires the referred to "least squares" fitting of a straight line of the form given in Eq. (1).

$$\left.\begin{aligned} a &= (\Sigma x^2 \Sigma y - \Sigma x \Sigma xy)/[n\Sigma x^2 - (\Sigma x)^2] \\ b &= (n\Sigma xy - \Sigma x \Sigma y)/[n\Sigma x^2 - (\Sigma x)^2] \end{aligned}\right\} \quad (1)$$

In this equation n becomes the number of strain-gage locations, and the values of x are the known locations of the gages. y is the strain-gage output proportional to the moment at each location. The equations can be transformed into the simpler form given in Eq. (2) where the values for a and b are obtained by multiplying by constants of the system.

$$\left.\begin{aligned} a &= k_{11}y_1 + k_{12}y_2 + k_{13}y_3 + \ldots \\ b &= k_{21}y_1 + k_{22}y_2 + k_{23}y_3 + \ldots \end{aligned}\right\} \quad (2)$$

where

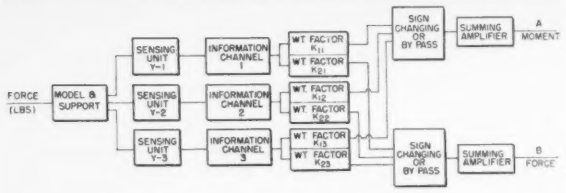


FIG. 3. Block diagram of force system.

$$k_{1q} = (\Sigma x^2 - x_q \Sigma x)/[n\Sigma x^2 - (\Sigma x)^2]$$

$$k_{2q} = (x_{qn} - \Sigma x)/[n\Sigma x^2 - (\Sigma x)^2]$$

Additional problems due to wind-tunnel testing are the tare corrections. These correcting or modifying terms arise from preloading of the sting, nonuniform flow in the tunnel, etc. Some of these terms are additive, others are multiplying terms.

The coefficient terms require division of the force values obtained by constants that are functions of the tunnel.

The pressure coefficient equation is presented in Eq. (3).

$$C_p = \frac{(P_1/P_b) - (P_a/P_b)}{(\gamma/2)(P_a/P_b)^{M^2}} \tag{3}$$

where

P_a = local ambient pressure
P_b = barometric pressure
P_1 = measured pressure
M = Mach Number

$$C_p = P_1 k_1 k_2 k_3 - k_3 \tag{4}$$

where

$k_1 = (1/P_b)f(\text{run})$; changes during day
$k_2 = (2/\gamma M^2)f(\text{tunnel})$; constant for a tunnel configuration
$k_3 = (P_b/P_a)f(\text{run and tunnel})$; barometric change during day, orifice location, configuration

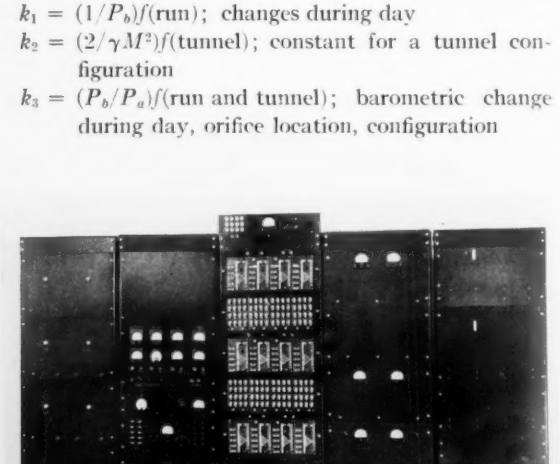


FIG. 4. Computer for automatic reduction of wind-tunnel data.

It can be seen that Eq. (3) degenerates into Eq. (4) with the linearizing assumption of small changes in the barometric pressure during the test run. Eq. (4) is then one of multiplication and addition of constants. The values of k_1 vary as the barometric pressure changes during the day. k_2 is a constant for any tunnel configuration. k_3 is a combination of variables that remain essentially constant during a series of tests. This function varies as the barometric pressure changes during the day, orifice locations on the model, configuration under test, and tunnel configuration.

(IV) Method of Solution

The solution of the force coefficient computation problem was accomplished by a system shown in block form (Fig. 3).

The force due to aerodynamic flow around the model causes strains in the sting. These strains are proportional to moments about the reference origin and are represented by the electrical output from the various strain-gage locations.

The signal in this system is an a.c. modulated carrier. It is passed through an "information channel" that gives d.c. voltages proportional to the strain-gage output times a multiplying tare factor. The d.c. voltage is then summed into d.c. operational amplifiers. In summing, then, the signals from various channels or stations are fed through weighting factors determined by the constants obtained by a process shown in Eq. (2). These factors are input resistors to the operational amplifiers.

The values of tares are known constants determined by tunnel configurations and set into computer before the test. The weighting factors are similarly known factors of model and sting beam design and can be set for any sting. The required constants to produce coefficients are simple resistance settings on the operational amplifiers.

Since the location of the origin is arbitrary, the values of k_{2q} from Eq. (2) can be positive or negative. This requires a sign changing amplifier for the determination of b.

The additive tare corrections are summed into the proper operational amplifier representing force or moment at the origin.

For the solution of the pressure-coefficient problem, the same equipment as that described for the force computation is used. An amplitude modulated carrier is obtained from linear differential transformers. This a.c. voltage is rectified and multiplied by constants k_1 k_3 of Eq. (4) in the "information channel." The weighting factor becomes constant k_2, and a voltage proportional to k_2 is summed into the operational amplifier. The output from the operational amplifiers is then the desired pressure coefficients.

(V) Components

The present computer consists of five relay racks. Rack 1 contains ten information channels. The second

rack is the master control panel and junction box and has the voltage regulation units for the main power supplies of rack 5. The third unit contains the d.c. operational amplifiers, their drift stabilizing units, and the weighting factors. Rack 4 houses the 2-kc. master oscillator, 400 cycles per sec. oscillator, and power supplies and their respective output amplifiers. The fifth rack contains all other power supplies. These racks are shown in Fig. 4. and are numbered from left to right.

The master control console, rack 2, contains the main operating switch. This switch controls channels for start, operate, or balance. In addition to this, there are monitoring meters of the d.c. voltages from the regulators, a.c. voltages from the oscillators, and a signal monitoring circuit for the information channels. By means of a multicontact switch, the d.c. output from any information channel can be read or monitored on a vacuum tube voltmeter located on the panel.

Rack 1 contains the heart of this computer—the information channel. The input to this channel is an amplitude modulated 2-kc. carrier with a 180° phase reversal for positive or negative actuating quantities. Fig. 5 presents a block diagram of the unit.

The a.c. signal is supplied to the signal amplifier through the input transformer and a 60-cycle rejection filter. This signal is amplified through the signal amplifier, the gain control of which represents a composite of the constant multiplying terms determined by calibration for each new test setup. This composite multiplying term can be determined by applying a known force and varying the gain of each channel until its output directly represents the applied force or moment.

The output is summed with a carrier so that the total output becomes amplitude modulated without a phase reversal. This summed signal is then rectified directly. At the same time, a carrier equal to that summed in is rectified through a separate diode bridge and subtracted from the above rectified signal. This yields a d.c. voltage proportional to the actuating quantity times a lumped constant of the system.

The zero balancing of the input signal is accomplished in two steps. The first step is the initial correction that is applied directly to the transducers to bring the zero point within the limits of the automatic balancing system and is manually accomplished when the test is first set up. The second step takes any normal zero shifts due to temperature and other causes and corrects for them by changing the bias voltage. This is done when the channel is not computing by sensing the d.c. output of the rectifiers and chopping and amplifying the error signal to a servomotor. This servo will vary the bias to bring the error signal to zero.

Indicator lights on the face of rack 1 light when the output voltage of the servo-amplifier is sufficient to operate the servomotor. Therefore, the light is on while the motor is attempting to bring the output to zero. If the light does not extinguish, it provides an indication of unbalance or zero shift greater than that

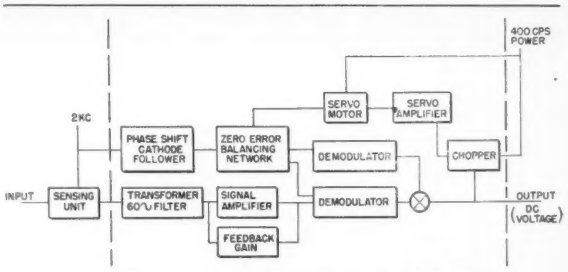


FIG. 5. Block diagram of one channel of information.

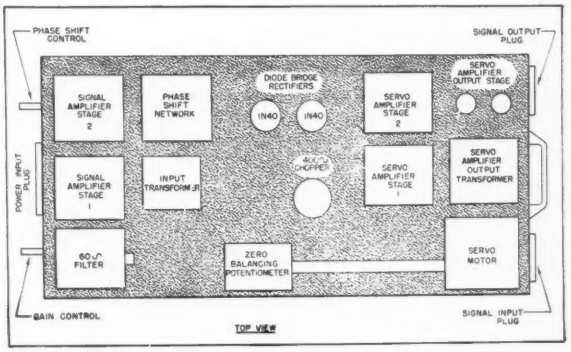


FIG. 6. Layout of information channel.

for which the automatic balancing system can compensate. Mechanical rebalancing of the transducer must then be accomplished. The physical layout of an information channel is shown in Fig. 6. All subunits have been placed in turrets, and each channel is a plug-in unit to facilitate easy maintenance and operation. The use of turrets has allowed the construction and detailing of a test routine to establish quickly which subunit has failed. Units can be quickly interchanged and the channel placed back into operation with a minimum delay. Fig. 7 shows an information channel.

Since both resistive bridges and differential transformers are to be used as end instruments, it is necessary to have a method for compensating for the phase shift between the biasing carrier and that coming from the transducers. This has been provided by using a phase-shift network before the bias potentiometer.

The composite multiplying term is obtained by variation of the feedback of the signal amplifier. Gain control is obtained by changing the feedback of the signal amplifier. The maximum gain is set by the minimum fixed negative feedback. This minimum is set by linearity requirements. The gain control provides as much as 50 db. variation. Maximum feedback before instability is greater than 65 db. The gain and the phase-shift controls are brought to the front of the panel as screwdriver adjustments to prevent accidental variation of the controls after they are once set.

In the University of Michigan Supersonic Wind Tunnel only two of the four arms of the strain-gage bridge are active. An adapter unit, shown in Fig. 7, contains

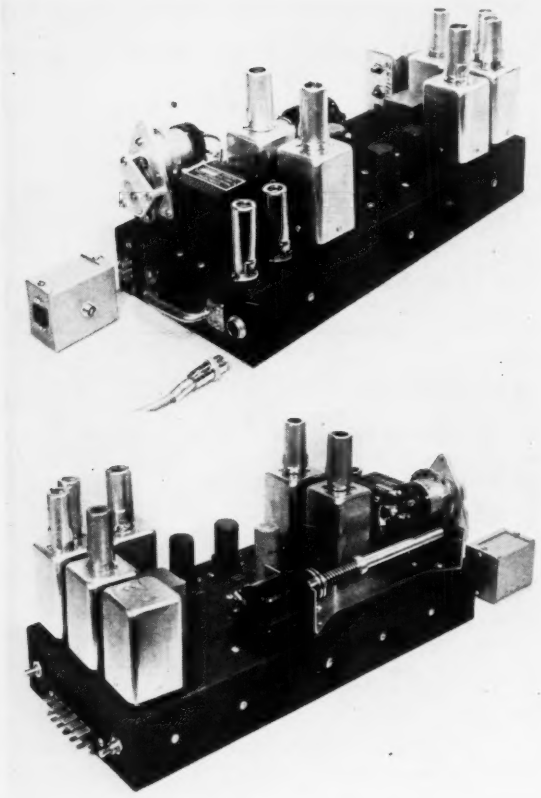


FIG. 7. Information channel.

the two nonactive arms of the bridge and the manual zero balancing potentiometer.

Because the accuracy of the entire Wind-Tunnel Data Reduction System depends directly upon the stability and accuracy of the transducer output, it is necessary that the amplitude stability of the carrier be one order of magnitude greater than the desired accuracy of the system. The type of oscillator chosen was a Wien Bridge oscillator because of its inherent stability in amplitude and frequency. It was thought that the amplitude control of this unit would be sufficient to give the accuracy required of the equipment; however, it was subsequently decided that increased accuracy could be obtained if a closed-loop servo system were added to the 2-kc. oscillator section. This would give added assurance that the overall design accuracy of 1 per cent could be obtained. The fundamental idea in this control involves driving a triode to cutoff and filtering out all frequency components except the first harmonic. This yields the desired sine wave. The output is fedback to control the triode cutoff.

The complete system, shown schematically in Fig. 8, accomplishes the desired amplitude stability by slicing the sine wave generated by the Wien Bridge oscillator. The sliced wave is passed through a low-pass filter and amplified. The carrier, which is applied to the transducer, is also rectified and compared to a d.c. voltage reference. The error signal is then amplified by a d.c. amplifier, the last stage of which governs the plate supply of the slicer and thereby regulates the amplitude of the carrier.

In order to carry on the necessary computations in the Wind-Tunnel Data Reduction System, it is necessary to employ a number of d.c. operational amplifiers. These units are similar to those used in electronic differential analyzers of the REAC, Goodyear, or RAND type. It was originally thought that commercially available units using a.c. drift stabilizing loops would be satisfactory. After several extensive tests, however, it was found that the a.c. frequency response was not satisfactory for the ultimate requirements of the wind-tunnel system, and a new d.c. operational amplifier and drift stabilizing unit was designed. This unit has an improved frequency response, allowing use of the equipment for frequencies an order of magnitude higher than commercial units. The desire for high-frequency response stems from one of the original design requirements to have this computer work on dynamic model tests and tests where several conditions are checked in a short time.

(VI) Accuracy

To date, no tests have been made using the equipment directly in connection with a wind tunnel. Tests are scheduled for September and October, 1952, and the unit is to be used as a full-time component of the University of Michigan wind tunnel in November, 1952.

Static tests of the system and its components have assured the authors that the accuracy will be better than the required 1 per cent. Linearity tests were conducted using no feedback on the signal amplifier. The results showed a linearity of better than 0.7 per cent. With minimum feedback on the signal amplifier this number should be around 0.1 per cent. The noise level with the maximum gain, open loop, was less than 0.06 per cent full scale. The automatic balance system corrects for zero shift and unbalance to an accuracy better than 0.05 per cent full scale.

Operational tests employing the equipment as it will be used in a wind tunnel have proved the unit to be more than satisfactory. Tests of individual components have been completed, and all units are well within the design accuracy range of 0.1 per cent.

The d.c. operational amplifier drift stabilization unit holds the drift to less than 100 microvolts, referred to the input. The frequency response of the d.c. operational amplifiers is 60 db. at 400 cycles per sec., open loop.

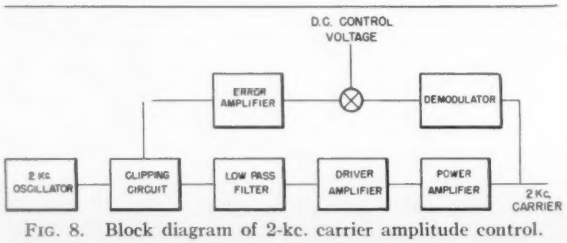


FIG. 8. Block diagram of 2-kc. carrier amplitude control.

(VII) Other Applications

One eventual use of this system is the application of the unit to dynamic testing. All components have been designed and selected with the requirement that signals with sinusoidal components up to 500 cycles per sec. can be tolerated and that there would be no loss in accuracy.

The field of flutter analysis using wind tunnels is one application. This computer would provide the initial step to automatic computation of the critical flutter speed or velocity. Another similar application is that of dynamic models in supersonic tunnels to obtain the dynamic coefficients similar to the normal static coefficients considered in this paper.

Propeller test facilities might also apply this type unit in the computational problems incurred in propeller vibrations, and power plant and rocket facilities are faced with similar semidynamic computation problems. Here it would be advantageous for the test conductor to see the computed results while the test is under way.

Another development presently to be tried with this computer is the weighted integration of pressure information over the test model to obtain force and center of pressure information. x-y plotters are to be used with this facility to obtain plots of the force coefficients vs. tunnel or aerodynamic parameters and pressure coefficient vs. position on the model.

(VIII) Summary

For an exact duplication of the present equipment, it is estimated that it would cost about $9,000. This unit contains ten information channels and five d.c. operational amplifiers. With this equipment it is possible to obtain three-component information—lift, drag, and center of pressure—or ten channels of pressure coefficients. To obtain six-component balance information, it is estimated that an additional $3,000 will be required.

Several features of this equipment appear to be new or novel and might be of value in many general problem solutions. One feature is the application of analog techniques to data handling and reduction; a second feature is the method of obtaining amplitude stability for the carrier; a third is servo balancing for zero shift; a fourth is the moderately low cost of duplication of the equipment; a fifth is the ease of maintenance and checking of the individual parts and the unit as a whole; a sixth is the versatility of the unit to be used for many types of similar problems; a seventh is the ability to follow dynamic phenomena and perform computations with sinusoid components up to 500 cycles per sec. Any of these features may border on being trivial by itself, but the overall system is thought to be a large step forward in moderate accuracy data handling; particularly for test installations where it is (or might be) advisable for the test conductor to have or see the results of the test during or immediately after completion of a run.

Changes of Address

Since the Post Office Department does not as a rule forward magazines to forwarding addresses, it is important that the Institute be notified of changes in address 30 days in advance of publishing date to ensure receipt of every issue of the *Journal* and *Review*.

Notices should be printed legibly and sent directly to:
Institute of the Aeronautical Sciences
2 East 64th Street, New York 21, N.Y.

Eighth International Congress on Theoretical and Applied Mechanics

N. J. HOFF*

Polytechnic Institute of Brooklyn

Historic Background

The Eighth International Congress on Theoretical and Applied Mechanics was held in Istanbul, Turkey, between August 20 and 28, 1952. A report on it to the members of the Institute of the Aeronautical Sciences is of particular interest because aeronautical engineers have always taken an important part in the organization of these congresses and have contributed a great deal to them by presenting and discussing papers. The whole idea of the modern applied mechanics congresses originated at a conference on hydro- and aerodynamics. The conference was held in Innsbruck, Austria, in September, 1922. It was initiated by T. Levi-Civitá, of Rome, Italy; C. W. Oseen, of Uppsala, Sweden; L. Prandtl, of Göttingen, Germany; and Th. von Kármán, of Aachen, Germany. During the conference, the organization of a congress dealing not only with aerodynamics but with the broader field of applied mechanics in general was proposed. It was mostly due to the efforts of Th. von Kármán that the proposition soon became a reality. Together with J. M. Burgers, of Delft, Holland, he began to organize the First International Congress on Applied Mechanics. The two were joined by C. B. Biezeno of Delft, Holland, who represented the point of view of research men in the theory of elasticity.

The First International Congress on Applied Mechanics was held in Delft, Holland, from April 22 to 26, 1924. The United States was represented on the Organization Committee by J. S. Ames, who was later honored by having named after him the aerodynamic laboratory of the N.A.C.A. at Moffet Field, Calif. When Dr. Ames was unable to attend, he was replaced by Jerome C. Hunsaker, who later became the first President of the Institute of the Aeronautical Sciences.

The First Congress was attended by over 200 persons who presented 76 papers. The Second International Congress on Applied Mechanics was held in Zurich, Switzerland, in 1926, with 86 papers on the program. It was attended by representatives from 22 countries. Stockholm, Sweden, was the host to the Third Congress in 1930. By that time, participation at the congress had increased to 186 papers and 597 members. The last two congresses before World War II were held in Cambridge, England, in 1934 and in Cambridge, Mass., U.S.A., in 1938. The series of congresses was resumed again after the war with the Sixth Congress held in Paris, France, in 1946, and the Seventh Congress in London, England, in 1948.

It should not be thought, however, that mechanics congresses were unknown before World War I. Long before aviation became a reality, structural and mechanical engineers organized meetings to promote applied mechanics. Thus, an International Congress of Applied Mechanics was held in Paris, France, in 1889 in connection with the exposition. About 350 persons attended this meeting, and the committee included members from 15 countries, among them the United States of America. Another successful International Congress of Applied Mechanics was held in Paris in 1900, at which, among others, W. F. Durand presented a paper. However, these congresses dealt mostly with advancements in steam engines, regulators, and mechanical testing, and the birth year of the modern congresses must be given as 1922.

Topics and Participants

The subject matter dealt with at the Eighth Congress was divided into five groups:

(1) Elasticity—Plasticity—Rheology.
(2) Fluid Mechanics (Aerodynamics—Hydrodynamics).
(3) Mechanics of Solids (Ballistics—Vibrations—Friction—Lubrication).
(4) Statistical Mechanics—Thermodynamics—Heat Transfer.
(5) Mathematics of Physics and Mechanics—Methods of Computation.

The official languages of the Congress were English, French, German, and Italian, but almost all the papers were presented and all the discussion took place in the first three languages, with English predominating. Several simultaneous sessions had to be held because the total number of papers scheduled was 340. Membership at the Congress was contingent upon the payment of a fee of $10. An associate membership was established for members of the families of the participants in the Congress who were invited to all the social functions but did not take part in the scientific activities. The total number of regular and associate members was 577, some of whom, however, did not reach Istanbul. Actually present in Istanbul were 334 regular members; this figure does not include the associates. The regular members attending originated in

Received December 1, 1952.

* Head, Department of Aeronautical Engineering and Applied Mechanics.

Old: The Mosque of Eyüp, a suburb of Istanbul. This mosque is one of the important shrines of the Moslem World.

24 different countries. Their numbers and home countries follow: Australia 2, Austria 1, Belgium 5, Denmark 4, Egypt 4, England 24, Finland 2, France 36, Germany 25, Greece 3, India 2, Iran 1, Israel 2, Italy 12, Japan 3, Malta 1, Netherlands 16, Norway 4, Pakistan 1, Sweden 12, Switzerland 4, Turkey 77, U.S.A. 90, and Yugoslavia 3.

Most of the world's leading scientists in the fields of applied mechanics were present at the meeting. The only important exception was Th. von Kármán, who, for the first time since 1924, was absent from an International Congress of Applied Mechanics because of family reasons. Several of the Americans remarked that they were unable to present papers in the United States to an audience of Americans of the quality of that in Istanbul. With the large number of papers presented, it is impossible to give an adequate coverage of the topics. The titles ranged from "A Boundary-Layer Theory for Elastic Bending of Plates" through "A New Cementable Material for Two- and Three-Dimensional Photoelastic Research," "New Engineering Problems in the Design of the Arnold Engineering Center," "Dynamic Instability of Systems Incorporating Pneumatic Tire Wheels, Its Cause and Cure," "The Formulation of Biharmonic Problems," "Criteria for Endurance Limits of Steel," "Statistical Aspects of Contact and Friction of Solids," "On a Generalization of Green's Formula," "Turbulent Diffusion," "The Calculation of Stresses for the Shell of Translation," "Discontinuity Properties of Flames and Measurement of Flame Speeds," and "On the Detachment of a Shock Wave from the Leading Edge of a Finite Wedge," to name a few at random.

General Lectures and Sectional Addresses

In addition to the papers submitted by the members of the Congress, a few general lectures and sectional addresses were given by prominent scientists who had been asked to speak on selected topics. The list of these lectures follows:

J. C. Hunsaker, Massachusetts Institute of Technology, Cambridge, Mass., U.S.A. *Social Aspects of Aeronautics.*

Antonio Signorini, University of Roma, Italy. *Quelques Recherches Récentes de Dynamique des Solides.*

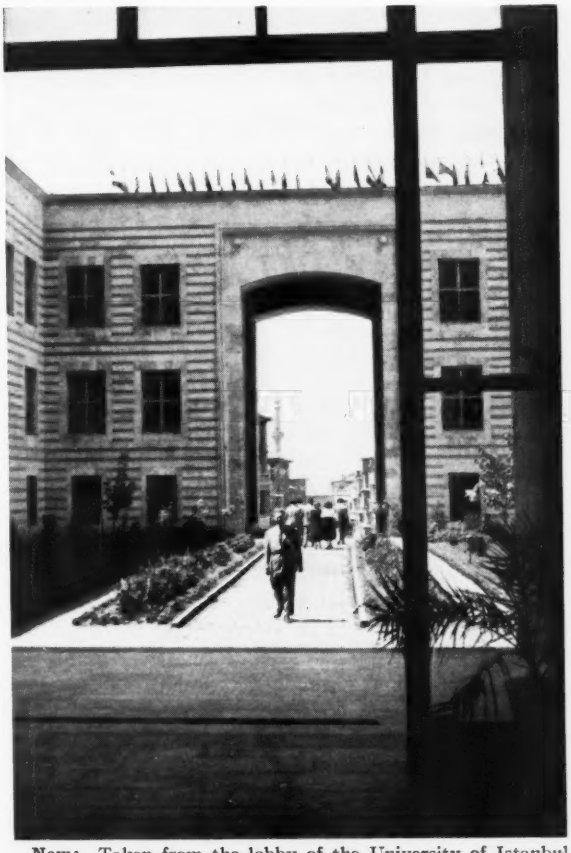
Hilda Geiringer, Wheaton College, Norton, Mass., U.S.A. *Some Recent Developments in the Theory of an Ideal Plastic Body.*

George Temple, King's College, London University, London, England. *The Dominant Derivative Method in Aerodynamics.*

Sir Geoffrey Taylor, Cambridge, England. *Hydrodynamic Theory of Detonating Explosives.*

John von Neumann, Institute for Advanced Study, Princeton, N.J., U.S.A. *Automatic Computation and Hydrodynamics.*

Johannes M. Burgers, Institute of Technology, Delft, Holland. *Some Statistical Problems Connected with Solutions of a Simple Nonlinear Equation.*



New: Taken from the lobby of the University of Istanbul where the meeting was held. In the background are shown the flags of all nations participating in the Congress.

Richard Courant, New York University, New York, U.S.A. *Reciprocal Variational Problems and Applications to Problems of Equilibrium.*

François N. Frenkiel, The Johns Hopkins University, Baltimore, Md., U.S.A. *Turbulent Diffusion.*

William Prager, Brown University, Providence, R.I., U.S.A. *The General Theory of Limit Design.*

Nicholas Minorsky, formerly Stanford University, Stanford, Calif., U.S.A. *Sur la Méthode Stroboscopique et ses Applications.*

Arthur Kantrowitz, Cornell University, Ithaca, N.Y., U.S.A. *Physical Phenomena Associated with Strong Shock Waves.*

Maurice Roy, Paris, France. *Du Combustible à la Propulsion.*

W. Tollmien, University of Göttingen, Germany. *Über Schwingungen in laminaren Strömungen und die Theorie der Turbulenz.*

Mauro Picone, University of Rome, Rome, Italy. *Sur une Méthode pour le Calcul des Valeurs Propres et des Fonctions Propres et sur son Application à l'Équation de Schrödinger.*

Markus Reiner, Hebrew Institute of Technology, Haifa, Israel. *Rheology of Second Order Effects in Elasticity and Hydrodynamics.*

André Lichnerowicz, Collège de France, Paris, France. *Méthodes Tensorielles en Mécanique.*

Nontechnical Remarks

Probably the greatest effect of an international congress upon the development of the art is not the stimulus it gives to the individual to prepare and present a paper but the opportunity it provides for the members to get together informally and discuss problems of common interest. Any observer present in Istanbul could notice that full advantage was taken of this opportunity. Scientists from all countries were milling around in the spacious lobby of the magnificent completely new building of the University of Istanbul in whose lecture rooms the papers were presented. Others sat around on the upstairs balcony where they could enjoy the cool breezes and see the breathtaking view of this city of hills and bays. The general lectures were given in the big auditorium of the University, which is superb in its simple modern design and its large seating capacity. Projectors for slides and film, time clocks, and personnel to operate everything were always available, and every paper was given exactly at the time provided for it on the program.

The hospitality extended by the Turks to their guests was overwhelming. Receptions were given by the rectors of the University of Istanbul and of the Polytechnic Institute of Istanbul. Tours were arranged to see the natural beauties of the Bosporus and the Princes Islands and the architectural monuments famed in Turkish and Byzantine history. Of these, the Aya Sofya commands the respect of every structural engineer. It is covered by a dome 107 ft. in diameter erected in 537 A.D. during the reign of the Emperor Justinian. Magnificent domes and slender minarets of mosques were visible at every turn of the curving narrow streets, and not the least of the pleasures of the visitor was haggling over prices in the covered bazaar. The banquet, at which members of the Congress and their families were invited guests, was given in the Casino, the most elegant place for dining and dancing in the city in the open air overlooking the Bosporus. It will be hard to excel this event at future congresses.

Organization

The organization of a congress of such proportions is an undertaking of considerable magnitude. It was directed by Prof. K. Erim, who with Mrs. Erim has been attending the Congresses for many years. Unfortunately, overwork exhausted Dr. Erim to such an extent that he was unable to open the Congress personally.* He was represented by Prof. Cahit Arf, another member of the Executive Committee. Professor Erim had the sympathy of all the delegates; they were very happy to greet him later at the final banquet of the Congress. Professor W. Prager, who taught in Istanbul before he joined the staff of Brown University, arrived 1 month ahead of the Congress to help with the organization.

The members of the Congress were greatly impressed with the help and attention received from the Turkish hosts who were always available for advice on technical, as well as on personal, matters. Without wishing to slight others whom the writer of this article did not happen to meet, the following names are mentioned: Prof. Giacomo Saban, who did most of the preliminary work of organization; Prof. Adnan Sokullu, Dr. Y. Garti, and Cenan M. Sahir-Silan; and Miss Alkmini Cariadaki, who knew every delegate by name, address, and professional connection. She, as well as Miss Armen Karaman and Miss Vera Steiner, was able to speak to practically every member in his native language.

Congress Committee

The organization of international congresses on theoretical and applied mechanics is in the hands of a committee that has been self-perpetuating since the time of the First Congress in 1924. The United States is represented on this committee by H. L. Dryden, J. C. Hunsaker, Th. von Kármán, and S. Timoshenko. F. H. van den Dungen was elected President of this committee for a period of 4 years, and R. V. Southwell was elected Treasurer. The next congress will be held in Brussels, Belgium, in 1956.

International Union

The International Union of Theoretical and Applied Mechanics also held a meeting during the Congress in Istanbul. This Union was organized in 1946 and is

(*Concluded on page 130*)

* It has just been learned that Dr. Kerim Erim died on December 28, 1952. This news will sadden all the members of the Congress, who cannot help realizing that the strain of being Chairman of the Organization Committee must have at least partially been responsible for his death. Our sympathy goes out to Mrs. Kerim Erim and the Polytechnic Institute of Istanbul for this great loss.

News of Members

(*Continued from page 19*)

cility, ARO, Inc., has been designated Manager of the Ram Jet Project Branch of the Engine Test Facility. In this position, he will be responsible for planning the first ram-jet engine development test to be conducted at the Arnold Engineering Development Center. In addition to the foregoing, Mr. Howard will continue to supervise the aerothermodynamic studies required in the determination of functional adequacy of the Ram-Jet Addition, a portion of the Engine Test Facility still in the design phase.

▸ **Julius Kendall** (T.M.) was recently elected a Vice-President of Greer Hydraulics, Inc. Mr. Kendall has been and will continue as General Sales and Service Manager, as well as Manager of the Research and Development Division of Greer.

▸ **Vice-Admiral Emory S. Land,** U.S.N. (Ret.) (F.), President, Air Transport Association of America, and wartime Chairman of the Maritime Commission, was the recipient of a new award created in his honor this year by the Society of Naval Architects and Maritime Engineers. The presentation was made in November at the society's Sixtieth Annual Meeting. This particular award is a gold medal given for "outstanding accomplishment in the marine field"; it will be known as the Vice-Admiral Jerry Land Medal. . . Admiral Land was recently named a member of the National Committee to Observe the Fiftieth Anniversary of Flight.

▸ **Robert B. Meyersburg** (A.F.), Chief, Flight Test Section, Civil Aeronautics Administration, Washington, D.C., has been appointed a member of a C.A.A. team to evaluate jet and turboprop transport aircraft.

▸ **Thomas A. Morgan** (A.M.) was elected to the Board of Directors, Pressed Steel Car Company, Inc., at its November 21 meeting. Mr. Morgan recently retired as President and Chairman of the Board of The Sperry Corporation.

▸ **C. R. Smith** (A.M.), President, American Airlines, Inc., was appointed a member of the Department of Defense's Citizens Advisory Committee on the Use of Manpower in the Armed Forces.

▸ **Robert A. Summers** (T.M.), Research Assistant in Aeronautical Engineering, Instrumentation Laboratory, Massachusetts Institute of Technology, returned last October from a M.I.T. Overseas Summer Fellowship at the Royal Institute of Technology in Stockholm, Sweden. Mr. Summers is continuing his work on his Sc.D. thesis at M.I.T.

▸ **Myron Tribus** (M.), Director of Icing Research, Engineering Research Institute, University of Michigan, received the Alfred Noble Prize for his paper on "Intermittent Heating for Aircraft Ice Protection with Application to Propellers and Jet Engines." The presentation of the Noble Prize was made at the recent annual meeting of The American Society of Mechanical Engineers.

▸ **Juan T. Trippe** (A.M.), President, Pan American World Airways, Inc., was awarded the Order of Merit for "extraordinary services to the peaceful recovery" of the Federal Republic of Germany. The presentation of this medal, the first given to an American citizen by the Federal Republic, was made on December 2 at the German Consulate General in New York City by Consul General Hans Riesser.

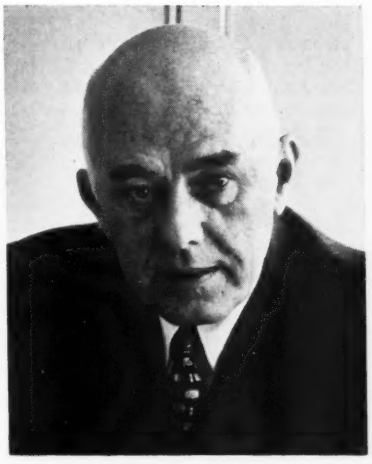
Members on the Move

The purpose of this section is to provide information concerning the latest affiliations of I.A.S. members. All members

Necrology

Justin A. Fitz

Justin Allen Fitz, A.M.I.A.S., died on his way home from work on the evening of December 9. His death was presumably caused by a heart attack.



Justin A. Fitz

Mr. Fitz was born on December 9, 1891, in Everett, Mass. He entered the U.S. Navy in 1910 and during his 4-year enlistment attended the Naval Electrical School. It was his experience in this field that led to his employment in 1914 by Sperry Gyroscope Company as a Technician on gyrocompasses and other special instruments. For many years, he served in various capacities of testing, sales, and service. He was one of those who made the first permanent installation of a gyrocompass on a ship on the Great Lakes. He was sent to Russia in 1929 to supervise the setting up and testing of gyrocompasses in government installations in Leningrad.

He was named Manager of Sperry's Publicity and Advertising in 1930. Thirteen years later, in 1943, he was made Director of Advertising and Public Information. His activities included the writing of instruction books, publicity, and advertising; for a number of years, he edited the house organ, *Sperryscope*.

Mr. Fitz is survived by his wife, Florence E. Fitz, and by his father and two sisters.

Ensign Forrest D. Swisher

Ensign Forrest Dean Swisher, U.S.N.R., T.M.I.A.S., was killed on last July 27 when his jet fighter collided with another just after taking off from the carrier, U.S.S. "Princeton," then in the Korean waters.

Ensign Swisher, who was born on March 2, 1927, in Amarillo, Tex., resided in Winfield, Kan. He was graduated in 1945 from the Winfield High School and 2 years later entered the Spartan College of Engineering. While enrolled at this school, he won the Scholastic Award of the local I.A.S. Student Branch. He was graduated from Spartan in June, 1949, with the degree of Associate in Arts in Aeronautical Engineering. Later, he attended the Armed Services Training Program at the University of Nebraska.

At the time of his death, he was serving as Naval Aviator and Assistant Maintenance Officer of Fighter Squadron 191, U.S.N.

are, therefore, urged to notify the News Editor of changes as soon as they occur.

Dr. Pericle A. Chieri (A.F.), Professor of Mechanical Engineering and Head, Department of Mechanical Engineering, Southwestern Louisiana Institute. Formerly, Associate Professor of Mechanical Engineering, Newark College of Engineering.

William H. Dammer (T.M.), Boeing Field Service Engineer, Boeing Airplane Company, Lowry A.F.B., Colo. Formerly, Engineer, Seattle Division, Boeing.

Hunt Davis (M.), Consulting Engineer, Worthington Corporation. Formerly, Division Engineer, Aerodynamics Division, Development Engineering Department, Elliott Company.

Fred Dell'Amico (M.), Head, Hydraulic Laboratory Section, Aero-Mechanics Department, Cornell Aeronautical Laboratory, Inc. Formerly, Head, Hydraulic Laboratory, Equipment Research Branch, Aero-Mechanics Department, Cornell.

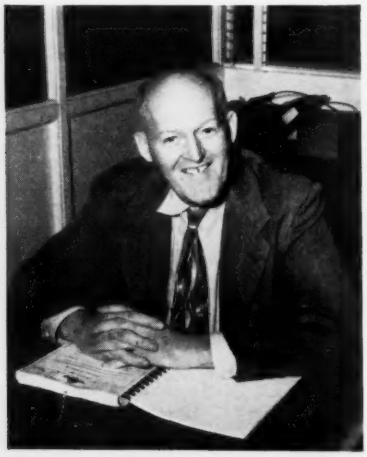
Prataprai Dinkerrai Desai (T.M.), now Aeronautical Engineer, Aircraft Design and Engineering Department, Hindustan Aircraft Ltd., Bangalore, Bombay, India.

B. J. Driscoll (M.), now Associate Director of the Secretariat, Advisory Group for Aeronautical Research and Development (AGARD), North Atlantic Treaty Organization, Paris, France.

David Eisenberg (T.M.), Test Equipment Engineer, Test Equipment Engineering Section, Planning and Tooling Department, Aeronautical Division, Hughes Aircraft Company. Formerly, Engineering Designer "B," Equipment Design Group, Radar Section, Research and Development Laboratories, Hughes.

RETURNS TO RYAN

Albert B. Deyarmond (M.), who was formerly Chief of the Special Studies Office, Air Technical Intelligence Center, Wright-Patterson A.F.B., Ohio, has returned to Ryan Aeronautical Company after an absence of more than 4 years. Prior to leaving Ryan in 1948, Mr. Deyarmond was Chief of Structures. He is now serving in the reactivated post of Chief of Structures at Ryan and is also Chief of Aerodynamics.



REJOINS BENDIX AVIATION

A. P. Fontaine (A.F.) returns to Bendix Aviation Corporation, after an absence of 6 years, as Staff Assistant to Raymond P. Lansing, Vice-President and Group Executive in charge of six eastern divisions of the corporation. In this position as Staff Assistant, he will help direct operations in aircraft control, navigation and instrument equipment, electron tubes, ignition systems, meteorological instruments, precision electrical units, etc. Mr. Fontaine, who holds twelve patents for aircraft and aviation components, was until recently Vice-President and General Manager of Consolidated Vultee Aircraft Corporation.

Bernard Goldman (A.M.), Senior Technical Writer, Publications Department, Ford Instrument Company, Division of The Sperry Corporation. Formerly, Supervisor of Technical Publications and Technical Editor, Stanley Aviation Corporation.

Harold E. Gray (A.F.), Vice-President—Atlantic Division, Pan American World Airways, Inc. Formerly, Vice-President—Pacific-Alaska Division, Pan American.

Ian A. Gray (M.), Director of Maintenance and Engineering, Canadian Pacific Air Lines, Ltd. Formerly, Assistant to the President, Canadian Pacific Air Lines.

Joseph P. Grieco (T.M.), Senior Test Engineer, Gas Turbine "A" Division, Wright Aeronautical Division, Curtiss-Wright Corporation. Formerly, Junior Test Engineer, Experimental Test Section, Wright Aeronautical.

Edward Eugene Henkel (A.M.), Public Relations Manager, Stratos Division, Fairchild Engine and Airplane Corporation. Formerly, Public Relations Manager, Fairchild Engine Division, Fairchild Engine and Airplane Corporation.

Clyde P. Jupiter (T.M.), Physicist, Navy Electronics Laboratory, San Diego, Calif. Formerly, Aerodynamicist, Santa Monica Plant, Douglas Aircraft Company, Inc.

Douglas A. King (M.), Senior Aerodynamics Engineer, The Glenn L. Martin Company. Formerly, Aerodynamics Development Engineer (Hydrodynamics), Bureau of Aeronautics, Department of the Navy.

Colonel C. R. Laubenfels, U.S.A.F. (M.), now Assistant for Flight Safety Engineering, Deputy for Operations, Wright Air Development Center, Wright-Patterson A.F.B., Ohio.

Ralph L. Merrill (M.), Engineering Designer (Armament), Long Beach Plant, Douglas Aircraft Company, Inc. Formerly, Engineering Designer, El Segundo Plant, Douglas.

Leonard M. Michal (T.M.), Assistant Project Engineer, Missile Design Section, Chance Vought Aircraft Division, United Aircraft Corporation. Formerly, Senior Electromechanical Engineer and Head, Data Reduction and Autopilot Analysis Group, The Glenn L. Martin Company.

Edward S. Miller (T.M.), Senior Flight Test Engineer, Flight Test Engineering Group, Chance Vought Aircraft Division, United Aircraft Corporation. Formerly, Project Engineer, Flight Test Division, Wright Air Development Center, Wright-Patterson A.F.B., Ohio.

Second Lieutenant David W. Peterson, U.S.A.F. (T.M.), Officer in Charge, Structural Engineering Branch, Feamcom Air Base, Japan. Formerly, Officer in Charge, Structural Repair, Kisarazu Air Base, Japan.

Emil A. Polowniak (M.), Chief Engineer, The Selb Manufacturing Company. Formerly, Hydraulic Group Engineer, Helicopter Division, McDonnell Aircraft Corporation.

MAJOR IN TURKISH AIR FORCE

Sadettin Güntürkün (M.), who received his B.S. in Aeronautical Engineering from Massachusetts Institute of Technology in 1946 and his M.S. from Polytechnic Institute of Brooklyn in 1948, was promoted on last August 30 from the rank of Captain to that of Major in the Turkish Air Force. Formerly at Tayyare Tamir Fabrikasi, Turkey, Major Güntürkün is now assigned to the 9. Av. [9th Fighter Squadron] Üssü, Balikesir, Turkey.

Another new development using

B. F. Goodrich Chemical *raw materials*

Photo and data courtesy of Thermoid Co., Trenton, N. J.
B. F. Goodrich Chemical Co. supplies the Hycar rubber only.

Why this HYCAR hydraulic hose has a long and useful life

YOU can see in this picture some of the tough conditions this hydraulic hose, made with Hycar rubber, has to meet—and *does,* to perfection!

One of them is oil, particularly high-pressure lubricants. Another is grease, including compounded greases carrying metallic soaps. Still another is corrosion from battery acid. There are the deteriorating effects of gasoline, plus abrasion from rough handling or dragging around to contend with. And the Hycar hose must remain flexible.

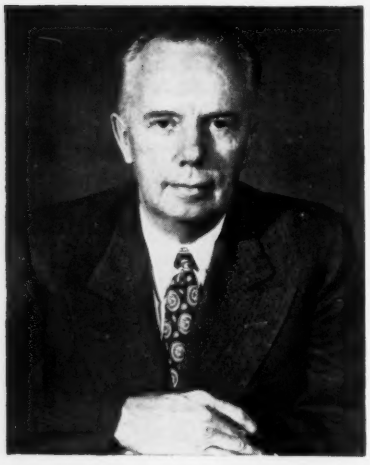
Hycar rubber comes through on every count. For Hycar is resistant to *all* these destructive conditions and more, such as heat and cold, aging and many chemicals.

Perhaps one of the Hycar rubber compounds can do a better job for you, help you improve or develop more saleable products. We'll help with technical information. Just write Dept. HF-2, B. F. Goodrich Chemical Company, Rose Bldg., Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B. F. Goodrich Chemical Company
A Division of The B. F. Goodrich Company

Hycar
Reg. U.S. Pat. Off.
American Rubber

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON organic colors



RETIRES

John K. Northrop (F.), I.A.S. Past-President, announced on last November 20 that he was retiring from the aeronautical field, because of "progressive impairment to his health." Succeeding him as President of Northrop Aircraft, Inc., is Northrop's Chairman of the Board and General Manager, Oliver P. Echols (F.). Mr. Northrop began his aeronautical career in 1916 and, prior to cofounding the company that bears his name, he was associated with Lockheed Aircraft Corporation and Douglas Aircraft Company, Inc. He is well known as the proponent and designer of the Flying Wing bombers built for the U.S.A.F. during and after World War II and was prominent in the design of the P-61 Black Widow, believed to be the first U.S. aircraft designed from its inception as a night fighter. In 1947, Mr. Northrop delivered the Wilbur Wright Memorial Lecture before The Royal Aeronautical Society.

AIRCRAFT SALES MANAGER AT PESCO

Bruce H. Pauly (M.) was recently appointed Aircraft Sales Manager at Pesco Products Division of the Borg-Warner Corporation. Mr. Pauly was formerly with Westinghouse Electric Corporation's Aviation Gas Turbine Division where, since 1945, he served successively as Design Engineer, Design Group Leader, and Section Engineer.

W. A. Reichel (A.F.), Executive Vice-President, Engineering, Kearfott Company, Inc. Formerly Vice-President and Director of Engineering, Kearfott.

Andre W. Reickel (M.), Engineering Business Manager, Kearfott Company, Inc. Formerly, Engineering Co-ordinator, Kearfott.

D. W. Smith (M.), Vice-President and Director of Engineering, Kearfott Company, Inc. Formerly, Associate Director of Engineering and Chief Engineer, Kearfott.

William J. Sullivan, Jr. (T.M.), Research Engineer, Scientific Research Laboratory, Ford Motor Company. Formerly, Research Engineer, Boeing Airplane Company.

S. Michael Treman (M.), Vice-President, The Parco Company. Formerly, General Manager, Fairchild Guided Missiles Division, Fairchild Engine and Airplane Corporation.

Robert H. Whitaker (T.M.), Lieutenant, U.S.A.F. Formerly, Student, Georgia Institute of Technology.

Corporate Member News

• **Airborne Accessories Corporation.** . . J. M. Walthew Company has been appointed representative for Airborne on aircraft applications in the Seattle, Wash., area. Jim Walthew and Burt J. Hall, T.M.I.A.S., provide technical representation at Boeing Airplane Company in Seattle.

• **Allis-Chalmers Manufacturing Company** . . .Bulletin 52B6975A, *Small Vertical Pumps*, which describes the construction features of Allis-Chalmers small vertical pumps for sidewall or submerged mounting is available on request from the company.

• **Aluminum Company of America.** . .In accordance with a contract recently concluded between the U.S.A.F. and Alcoa, two presses of 35,000- and 50,000-ton capacities will be operated by Alcoa in a Government-owned plant adjacent to the company's Cleveland Works. These presses, which will be used primarily to make structural aluminum and magnesium forgings for high-speed aircraft, will be put into operation in 1954.

• **Anderson, Greenwood & Company.** . . The company has moved from the Houston (Tex.) Municipal Airport to its new engineering and administration building at 1400 North Rice, Bellaire, Tex. (Bellaire is a suburb of Houston. The telephone number is Madison 2343. The teletype number is HO 477.)

• **Bell Aircraft Corporation.** . .The Fédération Aéronautique Internationale has accepted as an official world's record the September 17 flight made nonstop from Fort Worth, Tex., to Niagara Falls, N.Y., a distance of 1,217.137 miles. The flight was made in a Bell Model 47D-1 helicopter (Elton J. Smith, pilot) in 12 hours, 57 min., and 30 sec.

• **Bendix Aviation Corporation.** . .The delivery of the first mass-produced combustion self-starter for jet aircraft was recently announced. The starter weighs 75 lbs., burns a mixture of high-pressure air and jet fuel, and develops 340 hp. It is said to provide the first means of starting large jet power plants with a completely air-borne self-contained unit operating independently of ground crews. The starter was designed and developed by the Eclipse-Pioneer Division of Bendix and is being produced at the company's Utica, N.Y., division. . . .The guided missile development and production for the Navy has been expanded to include a new environmental test building adjoining its Missile Section plant in Mishawaka, Ind. . . .Production of electron tubes for aircraft and other highly specialized uses has begun at the new Eatontown plant of the company's Red Bank Division.

• **Boeing Airplane Company and Westinghouse Electric Corporation.** . .A new 36,000-hp. wound-rotor electric motor, built by Westinghouse, has been installed in the wind tunnel at Boeing's Seattle plant. This motor, in conjunction with the original 18,000-hp. motor previously used in the tunnel, will make a total of 54,000 hp. available to the test crews. When this tunnel resumes operation, it will provide air velocities in excess of Mach 1. The installation of this new motor is a part of Boeing's $1,500,000 improvement and modification program on the tunnel.

• **Cessna Aircraft Company.** . .The 1953 "Golden Year" Cessna 170, commemorating the Golden Anniversary of Aviation, was recently announced by the company. This model features many new improvements, in both design and equipment.

• **Cornell Aeronautical Laboratory, Inc.** . . .There were 196 new research contracts for the fiscal year ending June 30, 1952. The laboratory also reported activity on a total of 329 contracts throughout that fiscal year.

• **Curtiss-Wright Corporation.** . .George W. Hill has been elected a Vice-President of the corporation. Mr. Hill who has been Controller of Curtiss-Wright since 1949 will continue in that capacity.

• **Dzus Fastener Company, Inc.** . . .A patent was issued to William Dzus on last October 21 by the U.S. Patent Office for a new type of quick-acting self-locking fastener. The fastener, it is said, is particularly suited to securing water- and gas-tight casings and is currently being used on electronic, communications, and air-borne equipment. A small wire form replaces the usual receptacle or spring with the result that only a little mounting space is required in the supporting frame or casing. When the fastener is closed, the casing is held in a tightly sealed position by a pair of sturdy springs carried in the head of the stud. Exclusive manufacturing rights under the patent are held by Dzus Fastener Company.

(*Continued on page 56*)

Flexible

Improved New
VARGLAS SILICONE
Tubing and Sleeving

Now Varglas Silicone has been made more flexible. Sharp turns and 90° bends cause no cracking or peeling — no loss of dielectric strength.

As pioneers in the manufacture of silicone sleeving and tubing, we know this is the greatest improvement made during the past ten years. Unexcelled where high temperatures must be withstood for several hours — not just for 15 minutes. You need not sacrifice abrasion resistance and toughness to get flexibility. The new Varglas Silicone sleeving and tubing will pass cold bend tests at 35° to 40° LOWER temperature than formerly.

The only Class H insulation with all these features:

Efficient from 500° F. to — 85° F.

Moisture and Fungus Resistant

Flame Resistant — Self extinguishing

Abrasion Resistant

Dielectrically Strong with average readings up to 7,000 volts.

Available in 10 colors — at no extra cost.

Samples of Varglas Silicone products as well as samples of our complete line of tubing and sleeving are available in a convenient sample folder. Just drop us a line telling us your problem and its peculiarities.

Varflex
CORPORATION
Makers of Electrical Insulating Tubing and Sleeving

VARFLEX Sales Co., Inc.
311 N. Jay St., Rome, N. Y.

American Helicopter Society News

The Annual Forum

Plans for the Annual Forum of the American Helicopter Society include both participation in the Armed Forces Day Air Show and an industry exhibit to be held at a Washington hotel, according to Charles W. Lefever, Forum Chairman.

Dates for the Forum are May 14, 15, and 16. Saturday, May 16, is Armed Forces Day, when the Air Show will be held at nearby Anacostia Naval Air Station. On Sunday, the seventeenth, there will be a static exhibit of helicopters and other aircraft at the Air Station. The flying demonstration on Armed Forces Day will include a helicopter flight over Washington.

Warren Rockwell, of Hiller, is Chairman of the Air Show Committee. Other chairmen for the Forum are Tom Harriman, of Bell, for the Technical Committee; John T. Vest, of Sikorsky, for arrangements; Charles M. Seibel, of Cessna, for theory and design; Harry Tobey, of Piasecki, for development and test; Wayne Weisner, of Hiller, for maintenance and manufacture; and Wes Moore, of Chicago Airways, for flight operations.

The Awards Committee Chairman will be Bart Kelley, of Bell, last year's A.H.S. president.

Chairman Lefever has announced that the texts of the papers to be delivered at the Forum will be published in advance and will be on sale at the meeting.

A.H.S. Constitution

Work was started early in December on a revision of the Constitution of the American Helicopter Society. A committee headed by Ed Katzenberger, of Sikorsky, has formulated a new draft, scheduled to go before the Executive Board for review.

Legal aspects of the constitution still are being investigated by Executive Secretary Harry Lounsbury, and there are plans to rewrite the by-laws at a later date. The society members will be asked to vote on the new constitution after it has been passed by the Executive Board.

Major changes under consideration include the elimination of membership grades and new definitions of the duties of the Executive Board and Committees.

In addition to Katzenberger, those serving on the committee are Les Morris, of Kaman; Paul Stanley, of the Autogiro Company of America; Executive Secretary Lounsbury; and President T. R. Pierpoint, of Piasecki.

Meetings

American Helicopter Society members in the Philadelphia area had 2 busy days on December 11 and 12, when a Mideastern Regional Meeting was followed the next morning by an all-day session of the Second Convertible Aircraft Congress.

At the A.H.S. session, held at the Penn-Sheraton Hotel, papers were delivered by Morgan Smith and Jean H. DuBuque.

Mr. Smith, who is associated with the Ballistics Research Laboratories of the Ordnance Department at Aberdeen Proving Ground, reported on a study of the combat vulnerability of helicopters.

Mr. DuBuque, Executive Director of the Corporation Aircraft Owners' Association, gave a talk on "Commercial and Industry Uses of the Helicopter."

On December 12, A.H.S. members figured prominently in the Convertible Aircraft Meeting, held at Franklin Institute. Harry Tobey, of Piasecki, and Charles W. Lefever, of Prewitt, served as Chairmen of the two sessions.

Membership

Harry Lounsbury, Executive Secretary of the American Helicopter Society, announced that the membership drive currently under way is progressing well. Since the beginning of December, the total membership exceeded the 700 mark. New applications are being received daily.

As a result of a successful meeting of the New England Region on Monday, December 1, in Bridgeport, Conn., 45 new members were signed up. Miller Wachs, Mike Theodore, and the rest of the New England group are to be congratulated on the fine showing made at this meeting. Two other regions, the Mideastern and Southwest, have been most consistent in sending in new members each week. It shows that in some of the regions a large amount of effort has been put into the job of interesting people in becoming members of the American Helicopter Society. Lounsbury stated that he wished to thank the people in each region who are doing so much work on the campaign. The results so far indicate that the goal of 1,000 members by May, 1953, seems assured because of their efforts. If the other regions make a similar showing between now and May, we should exceed our goal.

CLAUDE O. WITZE
Publicity Chairman, A.H.S.

(*Continued from page 54*)

• **Ethyl Corporation.** . .A new Aeronautical Section has been established as a technical service activity for the aviation and petroleum industries. Ferd Gillig has been named Head of this section.

• **Flight Refueling, Inc.** . . .According to a November 26 release, an agreement has been reached—subject to stockholder's approval and other conditions—which provides for the transfer of a controlling interest in Flight Refueling, of Danbury, Conn., from Flight Refuelling, Limited, of England, to an American group that includes Reaction Motors, Inc., Laurance S. Rockefeller, A.M.I.A.S., and associates.

• **Flight Safety Foundation, Inc.** . . .The $25,000 gift recently given to the Foundation by Laurance S. Rockefeller, A.M.I.A.S., represents the largest single contribution received as of the middle of November, 1952, in support of an expanded program of safety promotion and education that has been in preparation since the early part of last year. . . .William P. Person has been appointed Manager of the Foundation's Air Transport Division.

• **General Electric Company, Aircraft Gas Turbine Division.** . .A new tank-mounted turbopump suitable for instantly supplying the extra supply of fuel required by jet engines for reheat operation has been announced. This pump, which combines boost, high pressure, and vapor separator elements into one unit, is driven by high-pressure air from the jet engine's compressor. It requires only a pneumatic connection with the engine and turns on or off automatically whenever the afterburner is needed. The pump is designed around the dual-rotor system, which involves two separate turbine wheels with no mechanical interconnection. One turbine drives the vapor separator and the low-pressure boost pump, while the other turbine drives the high-pressure pump element. The pump delivers approximately 86 gal. of fuel per min. at a

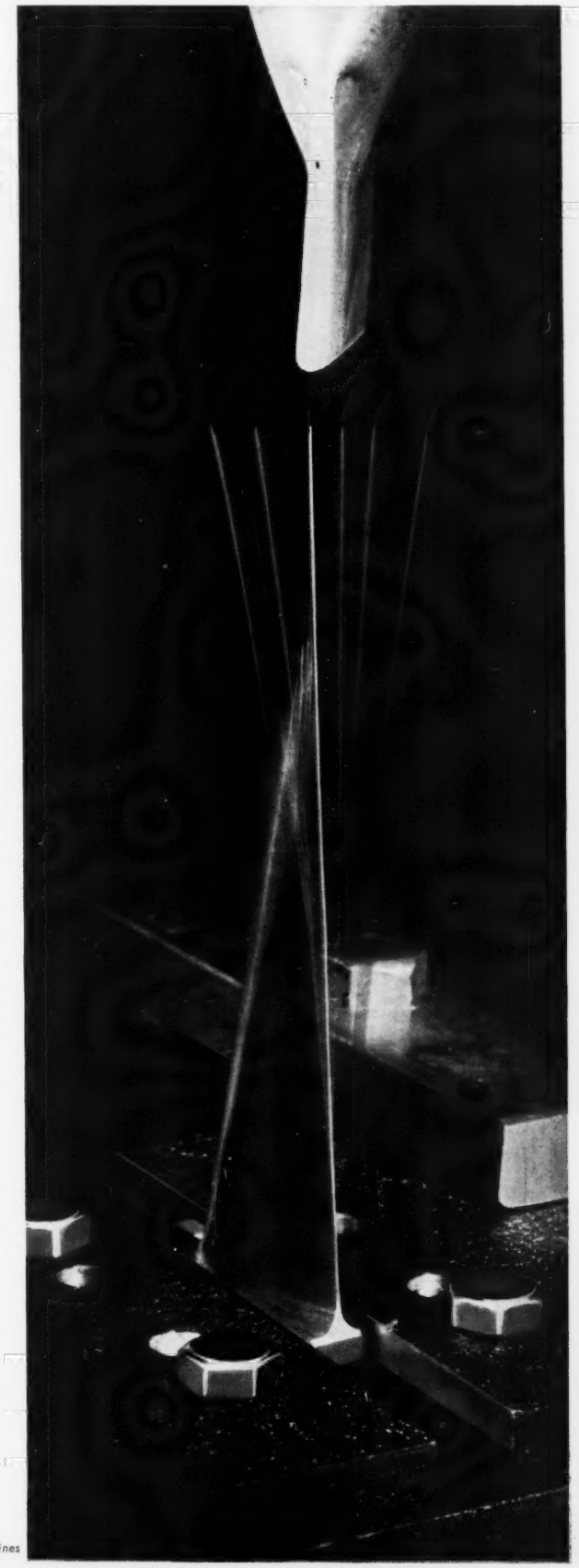
We air-vibrate blades to get longer life in jet engines

You recall the old trick in which a singer shatters a glass by holding a high note at the critical vibration frequency of the glass.

Here at Allison we use a similar idea to determine the fatigue life of jet engine compressor and turbine blades. By electro-magnetic, air jet (as pictured) or siren excitation, we stress-cycle the blade at increasing vibration amplitudes until its endurance limit is reached. This enables us to predict "critical" engine speeds—and with this data we modify blade design for higher performance and longer service life.

Then we go a step further: The information obtained in these laboratory tests is checked by installing strain gages on blades in running engines. This stress-measuring equipment had to be specially designed by Allison engineers to meet the high temperatures, since gages of this type were not commercially available. Many Allison engine improvements have been based upon the results of these tests.

All of this is one example of the engineering thoroughness that goes into every Allison jet engine — a thoroughness that pays off in the greater dependability that has won the confidence of American jet pilots everywhere.



Allison

GM GENERAL MOTORS

DIVISION OF GENERAL MOTORS
INDIANAPOLIS, INDIANA

World's most experienced designer and builder of aircraft turbine engines —J35 and J71 Axial, J33 Centrifugal Turbo-Jet Engines, T38 and T40 Turbo-Prop Engines

pressure rise of 510 lbs. per sq.in. The only necessary air connections protrude below the tank as the major portions of the unit are completely immersed in the fuel. No boost is required at the pump fuel inlet inasmuch as the pump is mounted inside the tank.

• **The B. F. Goodrich Company. . .** William S. Richardson has been elected a Director and Executive Vice-President of Goodrich, as well as a member of the Executive Committee. Mr. Richardson was formerly a Vice-President of the company.

• **Jack and Heintz, Inc. . . .** Two new bulletins, *No. 1351* and *No. 1150-1 (52)*, are available without cost from the company. The first one, *Bulletin No. 1351*, describes rotomotive equipment for standard and custom aircraft electric motors and electric and hydraulic actuators. The second one, *Bulletin No. 1150-1 (52)*, includes extensive technical data on the Jack and Heintz electrical control systems for generators and alternators designed for both aircraft and ground use.

• **Walter Kidde & Company, Inc. . . .** A new inhibitor that eliminates the corrosive effect of CB fire extinguishing liquid on aluminum through stabilization is now being used by the company's Aviation Department. All CB shipped by Kidde, since the additive was approved by the U.S.A.F., has contained the new inhibitor.

• **Lear, Incorporated. . .** The Civil Aeronautics Administration has certified the Lear L-5 Autopilot and Approach Coupler and Automatic Altitude Controls for use on the Douglas DC-6B and DC-6A air liners. . . . A 36-page booklet entitled *ADF Radio Compass Stations* which is "a concise and convenient guide to more than 2,500 radio stations throughout the U.S. suitable for Automatic Detection Finding," is available at $1.00 per copy by contacting the Lear distributors or the LearCal Division in Los Angeles. This Lear ADF station log contains data on low-frequency ranges, control towers, radio beacons, and I.L.S. compass locators. This information is organized and listed alphabetically by the name of town or city. The points covered are: station identification, location, frequency, power, type of antenna, type of facility, distance to nearest adjacent airport, and hours of operation. Magnetic bearings to the airport nearest to the radio facility, as well as a description of special D.F. characteristics of each type of station, are also mentioned.

• **Lockheed Aircraft Corporation. . .** The P2V-6 Neptune, powered by two Wright turbocompound engines, was specially designed for mine laying and antisubmarine warfare. This ship, currently undergoing flight tests, made its first flight on last October 14. The P2V-6, 12 in. longer than earlier Neptunes, carries a wide selection of secret armament. Its radar and wing-tip tanks are smaller than earlier models; pressure fueling and stainless-steel engine nacelles have been added. The plane is capable of operating from limited forward airfields and from carriers with eight 1,000-lb.-thrust JATO units. . .The Super Constellation, powered by Wright turbocompound engines, began an intensive test program on November 12 after having successfully completed its maiden flight. The first Super Constellation in the air was a Navy version, the R7V-1, capable of carrying 106 passengers and a four-man crew. With removable seats, it can be converted to either cargo or ambulance uses. In commercial service, the Super Constellation can accommodate 59 first-class or 99 tourist-class passengers. Delivery to the Navy was scheduled to begin before the end of 1952. Delivery to those air lines that have placed orders for this transport should get under way this year. . . .An advanced version of the Super Constellation, which had its first public showing on December 8, features several interiors. By removing certain bulkheads within the passenger compartment and moving the seats along slotted seat tracks so that they are of a higher density, the seating arrangement can be converted quickly from a 47-passenger super luxury plan to a standard luxury version with approximately 60 seats or to a tourist configuration with up to 94 seats overwater or 99 sets overland. This new Super Constellation is powered by Wright turbocompound engines and has a reported cruising speed of about 350 m.p.h. and a top speed approaching 400 m.p.h. . . .The responsibility for coordinating the planning, design, and ultimate construction for the projected multimillion dollar 5,000-acre jet flight center at Palmdale, Calif., has been assigned to Lockheed. Final approval of the master plan, which will call for an expenditure of an estimated $20,000,000 during 1953 and part of 1954, is expected momentarily from the U.S.A.F. The facilities at Palmdale, when completed, will be shared by North America Aviation, Inc.; Northrop Aircraft, Inc.; and Lockheed.

TURBOPROP-POWERED LIGHT PLANE

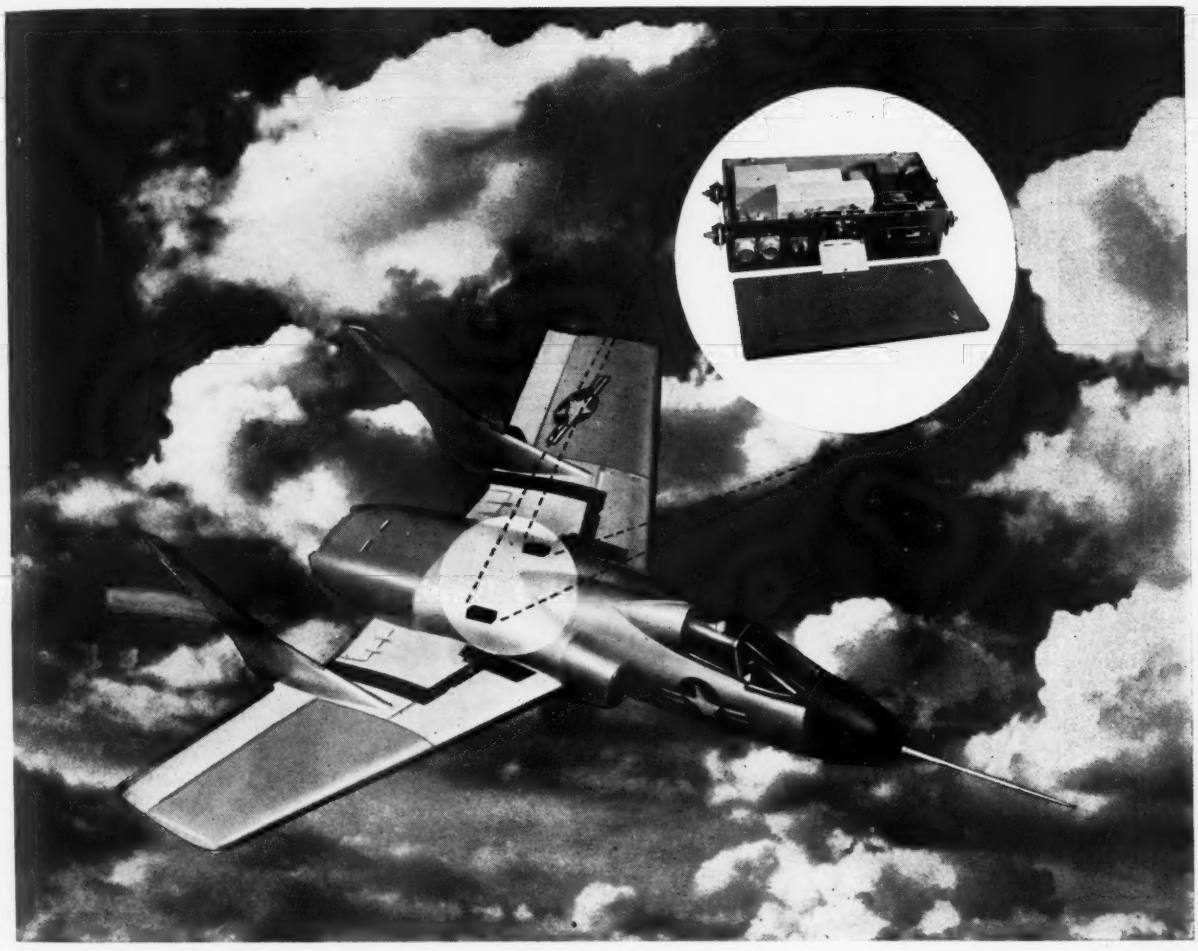
The Cessna XL-19B Bird Dog in combination with the new Boeing 502-8 aircraft gas-turbine engine, as shown in the above photograph, form what is believed to be the world's first light plane powered by a turboprop engine. It has been undergoing tests at Cessna Aircraft Company since its first flight on November 5. This turbine-powered light-plane project is a joint development program of Cessna, Boeing Airplane Company, the U.S. Army, and the U.S. Air Force. The engine is an outgrowth of a joint Boeing-U.S. Navy program of several years' duration. Shown in this photo as they inspect the engine installation prior to the XL-19B's first turboprop-powered flight are, from left to right: Harry McCarter, Cessna Project Engineer; S. R. Shannon, of Boeing's Gas Turbine Division; and Henry F. (Hank) Waring, M.I.A.S., Chief Engineering Test Pilot and Aerodynamicist at Cessna.

• **Loewy Contruction Company, Inc. . . .** Adam Zandel was named Executive Engineer in charge of Administration of the Engineering Department.

• **Minneapolis-Honeywell Regulator Company. . .** The development of an automatic pilot "designed to make automatic the whole procedure of flying a fighter plane, finding and attacking the target, and homing the plane," was announced recently by the Aeronautical Division. This device is formed by an automatic pilot tied in with a radar-fire control hookup. It has been designated by the U.S.A.F. as the E-11. . . .Three new engineering service and sales offices have been established in San Diego, St. Louis, and Philadelphia by the company's Aeronautical Division to provide expanded coverage for the aircraft industry. . . .Paul B. Wishart, Vice-President, was recently made General Manager and a Director of the company.

• **Northrop Aircraft, Inc. . . .** A new high-performance extreme-temperature chamber has been installed in Northrop's engineering laboratories for the purpose of testing components of the F-89D Scorpion and guided missiles. This chamber, which was designed for operation at any temperature between −100° and +250°F., was built by the Industrial Refrigeration Company of California in accordance with Northrop specifications. It was installed by Northrop to comply with stepped-up U.S.A.F. specifications for high- and low-temperature testing of components for jet aircraft and guided missiles. . . .Edgar Schmued has been appointed Vice-President in Charge of Engineering. As head of Northrop's engineering and design facilities, he will fill a position vacated by the recent retirement of John K. Northrop, F.I.A.S. . . . Richard W. Millar, formerly Chairman of the Board, has returned to Northrop's Board of Directors in order to fill the vacancy created by the recent resignation of Northrop's President, John K. Northrop. (See page 54.) Mr. Millar is a partner in the Los Angeles investment banking firm of William R. Staats & Company.

• **The Parker Appliance Company. . .** A High-Flow facility designed to test components to be used in high-speed fueling systems of aircraft was recently completed at Parker Aircraft Company, a subsidiary of Parker Appliance. This unit, contained within a 60- by 35-ft. steel-reinforced concrete walled area, is being used to refine elements of high-speed systems already developed by Parker Appliance and to test still newer equipment. Aviation fuel is supplied in this facility to



TURBOJET ENGINE

TEMPERATURE CONTROL AMPLIFIERS

You want and must have completely reliable temperature control amplifiers — amplifiers designed and constructed to meet specific basic requirements of your turbojet engines, such as:

1. Efficient operation in ambient temperatures from minus 65°F to plus 200°F.
2. Vibration endurance covering a range from 5 to 150 cycles per second.
3. Operation in altitudes up to 60,000 feet through the use of hermetically-sealed components.
4. Center-of-gravity shock mounting to permit installation right on the turbojet engine.

Manning, Maxwell & Moore turbojet engine temperature control amplifiers satisfy all four requirements. They incorporate a highly successful design principle thoroughly proved during years of concentrated research, development and tests devoted exclusively to automatic control systems for jet engines.

We believe our ability to apply our unique design technique to specific and unusual turbojet engine temperature control problems can be of real value to you. Our engineering counsel and extensive manufacturing and test facilities are at your service. We welcome your inquiry.

MANNING, MAXWELL & MOORE, INC.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

AIRCRAFT PRODUCTS DIVISION • STRATFORD, CONN.

OUR AIRCRAFT PRODUCTS INCLUDE: TURBOJET ENGINE TEMPERATURE CONTROL AMPLIFIERS • ELECTRONIC AMPLIFIERS PRESSURE SWITCHES FOR ROCKETS, JET ENGINE AND AIRFRAME APPLICATIONS • PRESSURE GAUGES THERMOCOUPLES • HYDRAULIC VALVES • JET ENGINE AFTERBURNER CONTROL SYSTEMS.

elements being tested at controlled rates of flow up to 1,200 gal. per min. to determine the characteristics and performance of fuel-system components. The fuel is delivered to this facility from two underground storage tanks by two large centrifugal pumps, one driven by a 50-hp. motor and the other driven by a 40-hp. motor. . . .A new bulletin, *4120-A1* on MS (military standard) aircraft flareless tube fitting, is available upon request to Parker Aircraft Company.

• **Radioplane Company.** . .M. W. (Kip) Tuttle has been elected a Vice-President of the company. In this capacity, he will handle Military Relations.

• **A. V. Roe Canada Limited.** . .A shaping machine that speeds up by 20 per cent the production of jet-engine turbine and compressor blades was recently developed at Avro, according to a recent announcement. This device has two cutters—one on either side of the workpiece—which is said practically to eliminate bending stresses. The supports for the workpiece and for the pattern are pivoted to accommodate the varying rake or incidence of the pattern tracers and cutters; this, the company says, results in "chatter" being nonexistent.

• **Simmonds Aerocessories, Inc.** . . .The construction of a new plant in Vergennes, Vt., for the precision manufacture of high-priority aircraft electronic and mechanical equipment is now under way. The new plant, situated on the west side of Vergennes overlooking the Otter River, is the first of a contemplated section building that ultimately will include the engineering and administrative activities of the Simmonds Vergennes manufacturing operations. Simmonds now has two assembly plants and an engineering laboratory in operation in Vergennes.

F-84F DELIVERED TO U.S.A.F.

The first production model of the swept-wing F-84F Thunderstreak, an advanced version of the straight-wing F-84 Thunderjet series, was accepted from Republic Aviation Corporation by the U.S. Air Force on December 3. Designed primarily as a fighter-bomber, Republic's F-84F can also be used as a fighter-escort or a fighter-interceptor. The "F" has a wing span of 33 ft., 7 in.; a length of 41 ft., 9 in.; and a height of 14 ft., 4 in., at the rudder tip. Its speed is given as being more than 600 m.p.h. The F-84F is powered by the J-65 jet engine, which was named the Sapphire by its original designers, Armstrong Siddeley, Ltd., of England, and is now being manufactured under license in this country by Curtiss-Wright Corporation's Wright Aeronautical Division and by General Motors Corporation's Buick Division.

• **Solar Aircraft Company.** . .A two-station, three-head transfer boring and facing machine was recently installed at Solar's San Diego plant. This 19-ton $90,000 machine is said to decrease by 87 per cent the time previously required to do all internal machining on J-47 jet-engine aft frames.

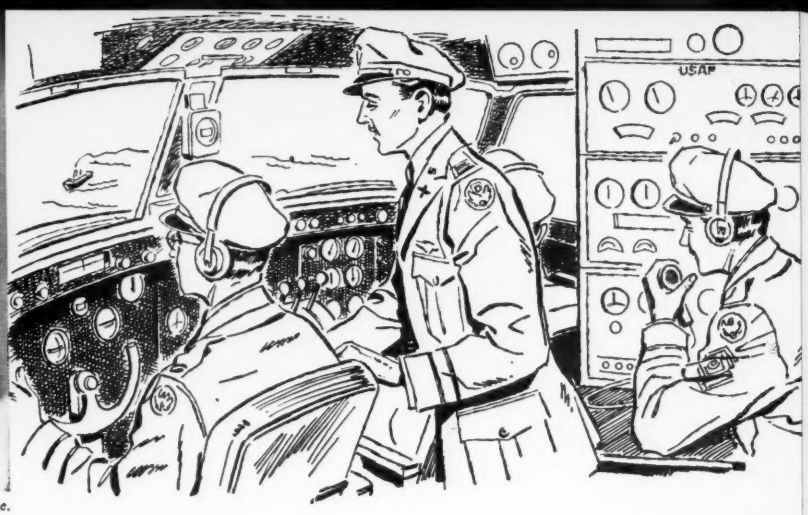
• **Summers Gyroscope Company.** . .A friction clutch that is said to be capable or self-adjusting for wear and expansion was recently announced. Company developing engineers report that this clutch can be used to replace conventional electromagnetic clutches. This unit is now being incorporated in at least two of the company's latest components.

• **Trans World Airlines, Inc.** . . .John E. Bierwirth, President, National Distillers Products Corporation, was recently elected a Director of the corporation.

• **Union Carbide and Carbon Corporation** . . .Flame Plating, a new method for applying hard, thin, precise coatings of powdered metals—such as tungsten carbide—on metal parts, has been developed by the Linde Air Products Company, a Division of Union Carbide. Tests, the company says, have shown that the coatings have wear and abrasion resistance that is as good as, or better than, sintered carbides. During the plating operation, the temperature of the base metal is said not to exceed 400°F., thus practically eliminating any possibility of a change in the properties of the part being plated and reducing to a minimum the chance that the part might warp. A new 12-page illustrated booklet on this subject entitled *Flame-Plating* has been published by Linde. This booklet, Form 8065, can be obtained gratis from the main Linde office in New York or from local Linde offices.

• **Vickers, Inc.** . . .The new plant at Joplin, Mo., with over 100,000 sq. ft. of floor space, began production of aircraft components about August 1. This facility provides greatly increased manufacturing facilities for Vickers' line of hydraulic pumps, motors, accumulators, and power transmissions supplied to the aviation industry. Manufacture of aircraft hydraulics for both military and commercial use is being continued at the Vickers' plant in Detroit. . . .The Vickers El Segundo (Calif.) Division is now designing and producing aircraft hydraulic equipment in addition to the sales and service activities. . . .The second Transport Aircraft Hydraulic System Conference, sponsored by Vickers, was held in Detroit, Mich., on October 28 and 29. Ninety-two participants from 51 industry organizations were present.

• **Weston Electric Instrument Corporation.** . .According to a recent announcement, the U.S. Signal Corps has given full qualification approval of the newly designed Weston panel instruments (Model 1521 class 52, 300 microamperes through 8 milliamperes d.c., inclusive) under specification MIL-M-10304. Complete information on the line is available in bulletin form which can be secured directly from the manufacturer.



Courtesy Lear, Inc.

in instruments where reliability is imperative

SILASTIC* works

where other materials fail

To assure maximum service life and accuracy, engineers at Lear, Incorporated, planned to protect their new vertical gyro-mechanism from corrosion by housing it in a completely inert and dehydrated atmosphere.

Sealing the housing, however, proved to be more easily said than done. Despite the most elaborate precautions, solder and flux fumes often penetrated the joint and contaminated the delicate mechanism. Once sealed, it was impossible to reopen the case without loss of the expensive cover and harness.

To both of these problems a simple and ingenious solution was found. A thin O-ring of Silastic molded to fit snugly under the cover flange is used to exclude the corrosive fumes generated in soldering a metal strip over the entire joint. The Dow Corning silicone rubber O-ring is not damaged by soldering temperatures. And, the gyro-mechanism is just as accessible for repairs as the contents of a hermetically sealed can of coffee.

Lear also uses a large ring washer of Silastic at each end of the housing to serve as resilient, shock-absorbing cushions for the apparatus at stratospheric temperatures.

And that's just one of hundreds of examples of how Silastic is used to improve the performance of products ranging from cable to traction motors, from domestic steam irons to aircraft.

*T. M. Reg. U. S. Pat. Off.

For more information about the properties or fabricators of Silastic, mail this coupon today or phone our nearest branch office.

Dow Corning Corporation, Dept. A-2, Midland, Mich.

Please send me:

- ☐ Silastic Facts 10a with new data on properties and applications of all Silastic stocks and pastes.
- ☐ "What's A Silicone?", your new 32-page booklet on silicone products and applications.

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

DEPARTMENT OF TECHNOLOGY
BUFFALO PUBLIC LIBRARY

FIRST IN SILICONES

DOW CORNING SILICONES

MIDLAND, MICHIGAN

Atlanta • Chicago • Cleveland • Dallas • New York • Los Angeles • Washington, D. C. • In Canada: Fiberglas Canada Ltd., Toronto • In England: Midland Silicones Ltd., London

I.A.S. Sections

Atlanta Section

Edith H. Lively, *Secretary*

The November 6 dinner meeting of the Atlanta Section was held at the Georgia Institute of Technology with Chairman George Baughman presiding. A brief business meeting preceded the program, at which time it was decided to have a field trip on December 6 to the Exposition Cotton Mills of Atlanta.

The speaker of the evening was Dr. August Raspet, Head, Aerophysics Department, Engineering Research Station, Mississippi State College, and an authority on gliders. He opened his talk with a description of the earliest known natural glider, the Zanonia Macrocarpa seed, native to Indonesia. From this, he moved on to gliders we know among the birds and recounted experiments and tests he had made with a turkey buzzard. Slides were shown of birds in flight and of sail planes used to study and copy the flight of birds.

Finally, Dr. Raspet showed the development of sail planes and discussed today's research and what research hopes to develop, both here and abroad, especially in Spain. A question and discussion period brought to a close a most interesting and informative meeting.

Baltimore Section

J. F. Maloney, *Secretary*

The thirty-eighth meeting of the Baltimore Section of the I.A.S. was held in Maryland Hall of The Johns Hopkins University on November 11, 1952, at 8:30 p.m. There were approximately 70 members and guests present.

The speaker was Paul A. Piper, Project Engineer at The Glenn L. Martin Company and recently Glenn L. Martin Resident Engineer at The English Electric Company, Ltd., designers of the Canberra.

Mr. Piper's association with the aircraft industry since 1929 in weight control and project engineer assignments has provided him with a broad background of American aircraft progress and well equipped him to contrast the current status of United States-United Kingdom competition.

"The British Aircraft Scene" as depicted by Mr. Piper in a discerning and understanding talk covered the following items, pointing out the differences rather than the similarities.

The British factories, in general, are out-of-date, especially with regard to facilities for mass production. However, the aircraft factories are not so much behind the times. Machine tools and assembly jigs are similar in type to American jigs; jigs are not as numerous, and there is a great deal more hand labor, especially concerning parts handling. The British are behind in industrial-engineering methods. The individual works harder for a lower rate of pay than his American counterpart. The British industry suffers from a man-power shortage aggravated by a housing shortage.

The engineering departments are smaller than those in America and concentrate on one or two models at a time. Scheduling of engineering is practically nonexistent, and the engineers have little in the nature of reports, extensive design calculations, governing specifications, and design regulations to routinize their jobs.

The procurement of new prototypes is done by means of brief, informal, preliminary proposals, and design calculations are a part of the contract. Design study contracts are not used to any extent.

The commercial airplanes most discussed were the de Havilland Comets, Vickers Viscount, and the Bristol Britannia. The military airplanes receiving most emphasis are fighters and interceptors such as the Gloster and Supermarine Swift. Bombers consist of the Canberra, Valiant, Avro Delta, and Handley-Page.

Remarks concerning the Farnborough Show pertained to the purposes of enabling the taxpayers to see the progress in aviation and of providing for industry familiarization and exchange of ideas.

The talk was an excellently organized and delivered report of "The British Aircraft Scene," depicting the general human and physical environments.

Buffalo Section

George B. Melrose, Jr., *Secretary*

The November 19 meeting of the Buffalo Section was held in the Crystal Room of the Touraine Hotel. A most enjoyable social hour preceded the meeting at which Chairman Al Krivetsky presided. The speaker of the evening was Maurice J. Zubkoff, Principal Engineer, Special Projects Department, Cornell Aeronautical Laboratory. He was introduced by Vice-Chairman Bill Champney. The talk was entitled "The Approach to Operational Analysis."

Mr. Zubkoff began his informative talk with background data on this relatively new field of science. He pointed out that operational analysis or research came into its own during World War II. Solutions were obtained to many problems that dealt with the operation of convoys, submarine action, radar countermeasures, patrol and search activities, and others. For a definition of "operational research," Mr. Zubkoff quoted Sir Robert Watson-Watt, originator of the term and an early worker in the field. His definition is: "The function of operational research is to examine quantitatively whether the user is getting the most from his equipment; what are the predominant factors affecting the results; what changes can be expected to improve the results; and the degree to which variations of tactics are likely to aid in attaining a strategic objective."

Mr. Zubkoff went on to discuss the formation of an operational-research group. He said that the men are frequently drawn from many diverse fields. Three of their prime attributes should be (1) having an unbiased point of view; (2) having a technical background that had taught them to reason logically; and (3) having incentive for solution, e.g.—a common desire for victory. He stressed the importance of the men having a sound background in their own field and of having the ability to think clearly—both of which aid in producing an unbiased approach to a given problem. The training of the men comprising such a group is primarily concerned with their becoming acquainted with the terminology and basic concepts of the field in which they are to work and of getting them to work together as a team.

Mr. Zubkoff outlined the solution of two typical problems for the audience, one demonstrating how results can be found when extremely little data are provided and the other applying considerable information to effecting a solution. A discussion and question period followed.

Cleveland-Akron Section

R. E. Bolz, *Secretary-Treasurer*

The November 25 meeting was sponsored by Thompson Products, Inc., and was held at the company's Auto Museum in Cleveland. There were approximately 180 members and guests at the dinner, which was preceded by a social hour sponsored by Thompson Products.

The main speaker of the evening was General Leighton Ira Davis, U.S.A.F., who is Director of Armament, Air Research and Development Command, Baltimore. General Davis graduated from the United States Military Academy in 1935 and

REDUX®

OPENING A NEW ERA IN AIRCRAFT ENGINEERING

The achievement of ways and means to assemble aircraft components with the "Redux" Process as developed by Dr. N. A. de Bruyne, Ciba's distinguished associate from England, has won widespread engineering and public attention both here and abroad.

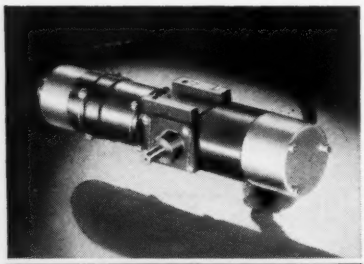
The acceptance of the "Redux" Bonding Process by the aircraft industry is confirmed by the fact that it has been adopted as the standard procedure in the production of commercial aircraft such as the de Havilland "Comet" and the Bristol "Britannia," as well as in a number of British military types. "Redux" bonding also is being used extensively for specially designed high-speed jet-fighters in this country.

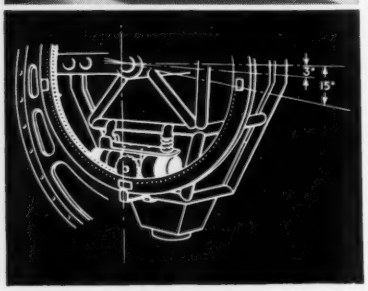
In response to long-standing invitations from American [illegible] societies and aircraft companies, Dr. de Bruyne is now [illegible] a specially arranged lecture itinerary to appear before these groups from coast to coast.

REPRINTS OF PUBLISHED PAPERS BY DR. DE BRUYNE ON THE "REDUX" PROCESS *and related data sheets have been assembled in a special reference file folder to serve as a preliminary guide to aircraft engineers in evaluating and using the "Redux" bonding process. Complete engineering assistance and information on the use of the process are available from Ciba. Address . . . Plastics Division, Ciba Company Inc., 627 Greenwich Street, New York 14, New York*

CIBA
PLASTICS

Cameras on Reconnaissance Planes Airborne Actuated





The R-118M6 Rotorac® is used on the Grumman F9F-5P and the Chance Vought F7U-3P to position the photo reconnaissance cameras.

The Airborne actuator is mounted on the camera cradle and its pinion engages a stationary internal gear segment. Five camera positions are obtainable: 3° or 5° and 15° below horizontal on each side, and vertical. The two extremes are controlled by the actuator limit switches; the others by limit switches on the gear segment. Internal switches in the actuator sequence the limit switches to permit the desired relocation.

The R-118M6 is a modification of the Rotorac shown in the I. A. S. Aeronautical Engineering Catalog. We suggest you refer to this publication for data on this and other Airborne actuators.

AIRBORNE
ACCESSORIES CORPORATION
1414 Chestnut Avenue, Hillside 5, N.J.

was commissioned as a Second Lieutenant. After flight training and assignment with the Air Force, he became an instructor in mechanics at the Military Academy. In 1941, he received an M.S. degree in Aero. from M.I.T. and in 1942 became Director of A.A.F. Ground School at the Military Academy. Since that time, he has held many responsible positions, including Chief of the Armament Laboratory, Chief of the Office of Air Research, and Commandant of the U.S.A.F. Institute of Technology. In 1951, he assumed his present position as Director of Armament.

His talk discussed the concepts of a military weapon system and, in a general way, discussed some of the engineering problems encountered in the achievement of a balanced weapon design. He stated that the probability of a successful kill for a fighter airplane in combat with an enemy is the sum of the individual probabilities of sighting, of closing in on the opposing aircraft, of hitting the opposing aircraft, and, finally, of the lethality of the hit. He indicated that the chief advantage of the American fighter planes over the Russian MIGS in Korea was the probability of hitting, and our advantage in this factor resulted from a small radar controlled, fire-control apparatus. The maximization of the sum of these four probabilities is what General Davis termed "the essence of the military weapon system concept."

Columbus Section

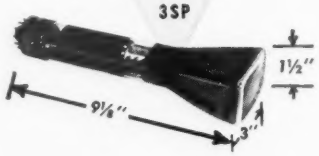
S. A. Gordon, *Secretary*

The first dinner meeting of the 1952–1953 season of the Columbus Section was held at the Officers' Club, Naval Air Station, Port Columbus, Ohio, on October 29. Approximately 130 members and guests were in attendance.

The business phase of the meeting consisted of the reading of the minutes of the previous meeting and the announcement of the affiliation of the local Section with the Columbus Technical Council.

Professor A. Tifford then introduced the speaker of the evening, Prof. J. Allen Hynek, Director, McMillen Observatory, The Ohio State University, who spoke on "Flying Saucers, The Universe and You." Professor Hynek discussed a number of sightings of "unidentified objects" and pointed out that approximately 20 per cent of the sightings are unexplainable, while the remaining 80 per cent were explained by physical phenomena such as balloons, light reflec-

THE RAYONIC®
CATHODE RAY TUBES
BY WATERMAN



Since the introduction of Waterman RAYONIC 3MP1 Tube for miniaturized Oscilloscopes, Waterman has developed a rectangular Tube for multi-trace oscilloscopy. Identified as the Waterman RAYONIC 3SP, it is available in P1, P2, P7 and P11 screen phosphors. The face of the Tube is 1½"x3" and the over-all length is 9⅛". Its unique design permits two 3SP Tubes to occupy the same space as a single 3" round tube, a feature which is utilized in the S-15-A TWIN-TUBE POCKETSCOPE. On a standard 19" relay rack, it is possible to mount up to ten 3SP tubes with sufficient clearances for rack requirements. Thus 3SP RAYONIC tube is ideal for multi-trace oscilloscopic work.

Maximum 2nd anode voltage 2750 volts ... Satisfactory operation can be achieved at 600 volts ... Vertical deflection factor 52 to 70 volts DC per inch per kilovolt ... Horizontal deflection factor 73 to 99 volts DC per inch per kilovolt ... Grid cut-off voltage 2.8 to 6.7% of 2nd anode potential ... Focusing voltage 16.5 to 31% of 2nd anode voltage ... Heater 6.3V at .6 amp ... Twelve pin small shell duodecal base ... Tube can be mounted in any position ... 3SP1 JAN approved.

WATERMAN PRODUCTS CO., INC.
PHILADELPHIA 25, PA.
CABLE ADDRESS: POKETSCOPE

WATERMAN PRODUCTS INCLUDE:
3JP1 & 3JP7 JAN RAYONIC CR TUBES
3JP2 & 3JP11 RAYONIC CR TUBES
3MP7 & 3MP11 RAYONIC CR TUBES
3RP1, 2, 7, 11 RAYONIC CR TUBES

Also POCKETSCOPES,
PULSESCOPES, RAKSCOPES
and other equipment

WATERMAN PRODUCTS

tors, airplanes; etc. He also discussed the possibility of such objects coming from other planets or galaxies. The vast distances in terms of light-years involved and the interspacial navigational difficulties in the location of earth within its own galaxy make such a possibility extremely remote.

The talk was illustrated by slides and was enthusiastically received by the audience. The meeting was concluded at 10:30 p.m.

Hampton Roads Section

H. Herbert Jackson
Recording Secretary

The first 1952 fall meeting of the Hampton Roads Section was opened October 22 by the new Section Chairman, John A. Harper, who introduced the new officers to the approximately 85 members and guests present. The new officers are: William L. Alford, Vice-Chairman; Albert L. Braslow, Treasurer; Julian D. Maynard, Corresponding Secretary; H. Herbert Jackson, Recording Secretary.

Melvin N. Gough then spoke to the section on, "My European Tour and the Farnborough Air Show." Mr. Gough is Chief of the Flight Research Division of Langley Aeronautical Laboratory, N.A.C.A. He has had a distinguished career as a Test Pilot, Research Scientist, and Consultant on aircraft operating and safety problems.

Mr. Gough flew to England at the invitation of the Society of British Aircraft Constructors to see an exhibition of new British aircraft and an air show staged in Farnborough by the Royal Air Force and the manufacturers. As a representative of N.A.C.A., he was also invited to visit several aircraft factories.

Mr. Gough took us on a quick trip to Europe and traced his trip on map slides. This trip was made in a C-54, and he was accompanied by others who were attending the Farnborough Air Show.

One of the things that greatly impressed Mr. Gough was the courtesy of all persons concerned with the air show. Mr. Gough took a great many excellent color slides throughout his trip. He had these slides projected and made interesting comments on each. These slides included the Fairey delta-wing missile, the Navy's Westland Wyvern T.F.4, the Avro Shackleton M.R.2, the Short S.A.4, the D.H. Heron, the Bristol Britannia, the Vickers Viscount, the D.H. Comet with its beautifully submerged engines, the E.C. Canberra on the ground and in flight, and the Avro 707A and 707B. Also shown were slides of the Avro 698 delta-wing bomber in flight, the D.H. Venom Night Fighter with its smooth-looking flush ducts, the Gloster Meteor T.7—a two-seater, the Navy's Hawker Sea Hawk F.1, and the Supermarine Swift F.1.

Mr. Gough was much impressed with the English engine knowhow and the manner in which they finish their planes down to the last detail. He stated that we have a great deal to learn from them on engine construction and airplane finishes.

Mr. Gough concluded his talk by showing some other excellent pictures taken throughout Europe.

Los Angeles Section

Harold S. Fischer, *Secretary*

"The Development Story of Project MX-883" was the featured subject of the Los Angeles Section's first security-classified monthly dinner meeting, held on November 20. Attended by a group of 400 I.A.S. members, the meeting was judged one of the Section's outstanding presentations of the year. The speaker, Dr. Frederick P. Jenks, Division Engineer, Guided Missiles, Lockheed Aircraft Corporation, who has directed this project since its inception, related an interesting account of the development of this high-speed flight article. Supplementing his talk, Dr. Jenks presented an unusually effective motion picture in sound and color, depicting actual test history of the project.

Preceding the closed portion of the program, the annual business meeting was held, and next year's Section officers were installed. The retiring officers—Allen E. Puckett, Chairman; Harold Luskin, Vice-Chairman; Earle S. Hodder, Secretary; and Howard E. Roberts, Treasurer—turned over their offices to their respective successors: Harold Luskin, Chairman; R. Richard Heppe, Vice-Chairman; Harold S. Fischer, Secretary; and Edward J. Specht, Treasurer.

Philadelphia Section

Emily Rogers Gibbs, *Secretary*

Alfred C. Loedding, Director of Jet Research, Unexcelled Chemical Corporation, Cranbury, N.J., was a guest speaker at the December 3 meeting at the Engineers' Club of Philadelphia. He gave an interesting and thought-provoking talk on "Jet-Assisted Take-Off and Rocket Propellent Models" and spoke of the development work he is doing in solid and liquid propellants.

The slides and movies showed his experiments through the years beginning with his first rocket-powered airplane model flown almost 30 years ago at Baden, Pa.

In an unusual historical review of aircraft configurations, he emphasized low aspect ratio and disc wings to achieve safety, performance, and practicability now demanded by the "aviation world."

Excellent slides were shown of the turbine flying machine (1893–1894) of Gustav Koch, of Munich; the apteroid biplane of 1910 by Flick-Reinig, a German architect; through the Huth biplane of 1909 with an annular-type wing, Kitchen's doughnut (British) of 1911, and the Tilghman Richards monoplane of 1912.

Also shown were the Russian parabola glider of 1924 by B. I. Tschevanowsky; the 1933 annular wing of Antes, the German sculptor; the 1934 disc wing of the Austrian Raoul J. Hoffman; and the Warren and Young British model of 1937 where the elevator was between fin and fuselage.

Flying saucers, space travel, and solid-fuel rocket motors were integrated into the discussion.

Motion pictures of his models showed his early work on jet-propelled aircraft and how that work aided projects at Wright-Patterson A.F.B. on Jet Propulsion Research and Development and the "Flying Saucer Project."

He also revealed that the Unexcelled Chemical Corporation under his directorship has developed new solid-fuel propellants and extremely lightweight inexpensive motors that promise to play a major role regarding rockets, JATO, boosters for guided missiles, gas generators, and other related articles which will have great commercial, as well as military, value.

In closing, Mr. Loedding asked his audience to consider that, if we are to attain the outer reaches of space, we will have to find something other than "force."

He raised the question of the possibility of changes man might have to make in the conception and acceptance of the law of gravity and inertia and to realize that some schemes for the transformation of energy into different forms or stages will have to be effected if interplanetary journeys are to be attained.

San Francisco Section

E. A. Quarterman, *Secretary*

The meeting of November 20 was held at Ramor Oaks, Redwood City, Calif., at 8:00 p.m. Forty-five members and guests attended the meeting.

Willis M. Hawkins, Jr., of Lockheed, was the speaker and discussed his company's studies of jet trans-

ports. Using the Chicago Airport as the base of his performance studies, he developed the necessary characteristics for a jet transport operating from such an airport. It was then pointed out that air-line use of such an aircraft would reduce the number of aircraft needed because of the speed of the aircraft. Possible configurations of such aircraft were illustrated with slides, and it was pointed out that the most likely arrangement was that of a swept-wing aircraft having four jet turbines buried in the fuselage aft of the trailing edge of the wing. Mr. Hawkins stated that the cost of building such an aircraft might be expected to be of the order of four times the capitalization of his company, whereas the Lockheed "14" was developed for 100 per cent of the company's capitalization.

An extended discussion followed the presentation of the speaker in which the advanced accomplishments of our British brothers were pointed out.

An announcement was made of the election of the following officers for the 1952–1953 term: Chairman, H. Julian Allen; Vice-Chairman, Steven E. Belsley; Secretary, Comdr. E. A. Quarterman, U.S.N.R.; and Treasurer, E. V. Laitone.

Seattle Section

Al Jarvis, *Secretary*

The November 19 dinner meeting, held at Sand Point Naval Air Station, opened with the introduction of the newly elected officers: B. F. Ruffner, Chairman; G. E. Ledbetter, Vice-Chairman; A. J. Jarvis, Secretary; and W. T. Hamilton, Treasurer. All are members of the Boeing Airplane Company engineering staff. Introductions were made by the outgoing Chairman, D. B. Martin, who then turned the meeting over to the new Chairman.

Speaker for the evening was W. W. Kellogg, coauthor with W. F. Hiltner and P. D. Johnson, of the paper, "Feasibility of Space Travel." All three are members of the American Rocket Society and the British Interplanetary Society. Mr. Kellogg gave an excellent talk, accompanied by a motion picture, *The A-4 Rocket*, known to the Allied powers as the V-2, and by slides concerning the various parameters of space flight.

Mr. Kellogg pointed out gaps in present knowledge such as radiation influences outside earth's atmosphere, physiological effects of apparent weightlessness, etc. Curves showing mass ratios for various fuel-oxidizer combinations with multiple-step systems pointed up the engineering problems involved in the space vehicle itself. The need was stressed for intensive research to provide proper data for correct extrapolation. The talk covered the subject in all aspects to an exceptional degree and was well received by a capacity audience.

The next meeting, January 6, 1953, will be the Sixteenth Wright Brothers Lecture to be held at the University of Washington with Otto E. Kirchner, Director of Operational Engineering, American Airlines, giving William Littlewood's lecture, "Technical Trends in Air Transport." Mr. Littlewood is Vice-President, Engineering, American Airlines, Inc.

Texas Section

Howard F. Marx, *Secretary*

At Texas Section's November 7 dinner meeting, 200 engineers and guests gathered at Midway Inn, Arlington, Tex., to hear two outstanding engineers discuss current British aircraft and the design practices underlying their development. H. W. Hinckley, Assistant Chief Engineer of Convair's Fort Worth Division, delivered "A Report on the Farnborough Air Show," and J. G. Willis, former Assistant Chief Designer of A. V. Roe and Company, Ltd., in England, compared "British Versus American Design and Production Practices."

Chairman William Clegern opened the meeting with a statement of the aims of the new officers: (1) Separate panel meetings for technical specialists will be scheduled. (2) Efforts will be made to establish a student competition—first, locally, then, expanded later to be national in scope. Howard Marx, Convair Aerophysics Engineer, then presented a humorous skit entitled "Movies Are All Alike."

The speakers for the evening were introduced by Robert Lemmon, the committeeman who was responsible for the formal program. Mr. Hinckley illustrated his review of British aviation progress with color motion pictures taken on the spot at the recent Farnborough Air Show staged by the Society of British Aircraft Constructors. He expressed particular admiration for the low-speed handling qualities of the Gloster Javelin and commented on the flying exhibition of the Avro 698 delta-wing bomber, which had had only 4 hours of flight time prior to its appearance at the show. In comparing British and American progress, Mr. Hinckley stated that he believes both countries are about equal in jet-engine development, but the British are definitely ahead in the development of turboprop power and in the application of jet engines to commercial aircraft. "It is obvious," he said, "they have them [commercial jet and turboprop transports], and we don't."

Mr. Willis described the organization of comparable British and American aircraft facilities by means of illustrated charts. The typical American organization chart was characterized by solid lines of clearly defined authority. "Note the absence of dotted lines [of authority]," he said, "which enable a man to sneak around the back door and get something done." Mr. Willis expressed amazement at the large engineering staffs in American plants. "The average engineering department in America is about three times as large as that in England. The outputs," he quipped, "are about the same."

A short period of informal discussion concluded the meeting.

Toronto Section

R. T. Gibson, *Secretary*

The Toronto Section was fortunate to have as its speaker on November 5 Air Commodore C. L. Annis, Scientific Advisor to the Chief of Air Staff, R.C.A.F. He spoke on the subject, "Scientific Trends in Air Power" and was introduced by Chairman K. L. Molson.

Defining air power as "the power of applying human progress in conquest of the air militarily, to gain conquest in the air," the speaker traced its growth from the first powered flight on December 17, 1903, up to the present time. Emphasizing the youth of the Air Force, he pointed out that prior to World War II, only seven nations maintained Air Forces of equal status with land and sea forces.

The speaker referred to the relationship between fighter and bomber aircraft in speed and maneuverability. He stated that in the past, with each new bomber design, it appeared as though fighter aircraft would no longer be able to maintain the necessary margin in performance. However, history has shown that this is not true. He expects that once again fighters will be developed which possess adequate performance reserves when compared to today's and tomorrow's advanced bomber designs. A major factor contributing to this goal is the use of electronic equipment. This is, in effect, turning night into day in Air Force operations.

Air Commodore Annis commented on the increased use of technical aids in personnel training. Mobile training units and flight simulators are now being used widely. Although a flight simulator for a transport air-

The Most Trusted Name in Ignition

meets the operating needs of every plane

No single type of ignition equipment is the final solution to every operating problem. That's why Bendix approaches each new assignment with an open mind. The particular type of ignition system recommended is decided on the basis of meeting individual requirements for economy, performance and dependability.

Of one thing you can be certain, from the broad Bendix experience and unrivaled facilities will come ideas and products tailored to your needs. For piston, jet, turbo-jet or rocket engines every component part of your ignition system will meet the uncompromising standards of quality established by Bendix over a quarter of a century ago.

This combination of facilities and skill is ready to go to work for you in the solution of any ignition problem from planning to finished product.

AVIATION PRODUCTS

Low and high tension ignition systems for piston, jet, turbo-jet and rocket engines . . . ignition analyzers . . . radio shielding harness and noise filters . . . switches . . . booster coils . . . electrical connectors.

Bendix

SCINTILLA MAGNETO DIVISION
SIDNEY, NEW YORK

Export Sales: Bendix International Division
72 Fifth Avenue, New York 11, N. Y.

FACTORY BRANCH OFFICES: 117 E. Providencia Avenue, Burbank, California • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan • Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California

craft operated by the R.C.A.F. had cost over half a million dollars, this investment was considered a major economy in training programs.

The speaker referred to the Korean War as a testing ground, as was the Spanish War prior to World War II. He expressed the opinion that it is a giant fighter training ground for the enemy. As such, it is proving of greater benefit to them than to the United Nations forces.

Following a lively discussion period, Air Commodore Annis was thanked by Mr. I. M. Hamer, Technical Director of Dowty Equipment Company of Canada, Ltd.

Wichita Section

Donald J. Ahrens, *Secretary*

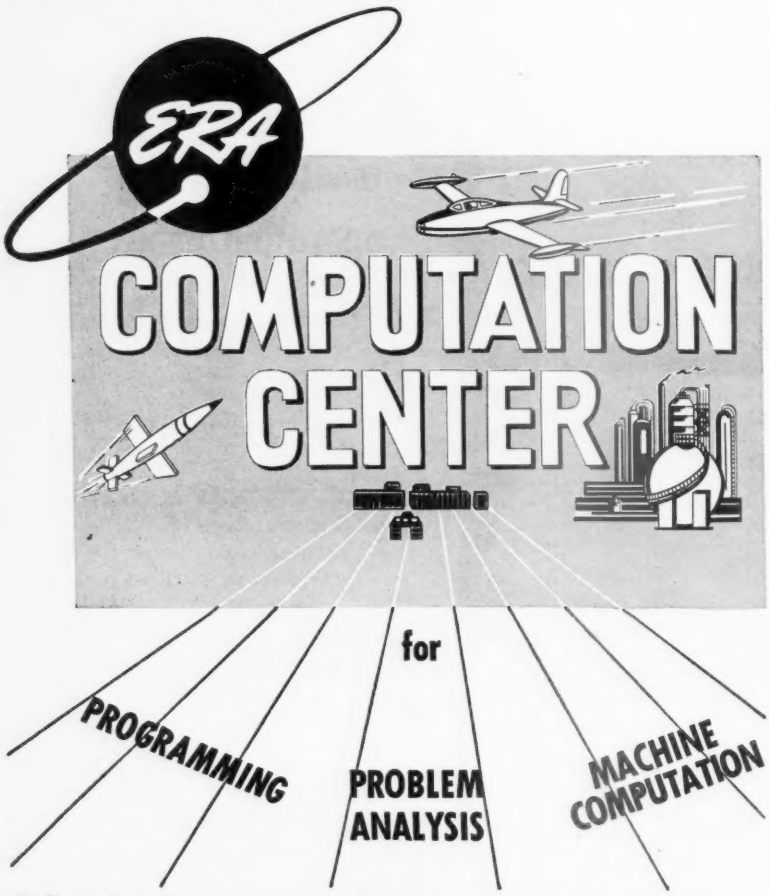
Approximately 100 members and guests were present at the October 8 dinner meeting of the Wichita Section held at the Hotel Broadview. Professor Melvin H. Snyder, Jr., Chairman, presided at the meeting and introduced Charles M. Seibel who discussed the latest trends on design and development of helicopters. Mr. Seibel is well qualified to speak for the helicopter field, since his experience consists of several years with Bell Aircraft Corporation, President and Chief Engineer of the Seibel Helicopter Company, and Chief Engineer of the newly formed Helicopter Division of Cessna Aircraft Company. The discussion was supplemented by two sound films, *Helicopters in Korea* and *Utility Unlimited*.

▶ The November 5 dinner meeting held at the Lassen Hotel consisted of a discussion of "Titanium in Aircraft" by Frank H. Vandenburgh, Vice-President and General Manager of Mallory-Sharon Titanium Corporation. Introduced by Professor Snyder, Mr. Vandenburgh briefly presented the history of the element and followed this with a detailed account of the many problems encountered in producing the various alloys and the further problems of fabrication. Several samples of alloys, forgings, spot welds, and machining were examined with comments regarding cost, ease of fabrication, and availability. It appears that titanium has great potentialities but is, as yet, in its infant stage.

Attention Members!

All members of the Institute are invited to submit material concerning their activities for publication in the "News of Members" columns of the *Aeronautical Engineering Review*.

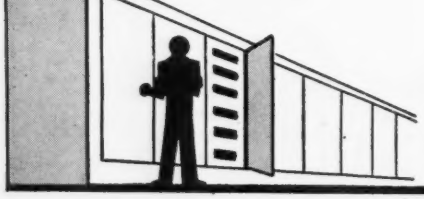
ANNOUNCING THE



A Complete New Computing Service . . . for industries and government agencies confronted with large-scale data-processing problems.

Flexibility of Service . . . permits you to utilize the facilities you need . . . ERA specialists will handle your problems from problem analysis to final results . . . various services may be purchased singly or in any combination.

The ERA 1101 Computer . . . is the core of the new ERA Computation Center. ERA's extensive experience in programming and operating the 1101 assures efficient processing of your problems.



We Invite Your Inquiry.

For additional information on the facilities and services of the ERA Computation Center write to Dept. AE-1

Engineering Research Associates
Division of Remington Rand INC
COMPUTATION CENTER, 555 23rd Street So., Arlington, Virginia

Student Branches

Academy of Aeronautics

Frederick Berger
Corresponding Secretary

On November 12, a group of I.A.S. Student Members from the Academy of Aeronautics joined the S.A.E. Academy Student Branch in a field trip to New York International Airport at Idlewild. About 100 students took part in this memorable event, sponsored jointly by the Port of New York Authority, Civil Aeronautics Administration, and Pan American World Airways, Inc. Among the many points of interest visited, the following attracted particular attention: a navigational-aid exhibit in the lobby of the C.A.A. building; the airport control tower; and a Pan American stratocruiser.

▶ A Shell Oil Company film, *Flight Log*, was shown at the November 13 meeting, at which 36 students were present and Chairman Sherman Martin presided. The film, which was narrated by Gen. Jimmy Doolittle, showed the development of aircraft and engines and the role fuel played in man's conquest of the air.

▶ Another interesting field visit took place on December 2 at Republic Aviation Corporation. Thirty members had the opportunity of viewing most of the engineering offices, testing laboratories, machine and work shops, subassembly and final-assembly halls. The entire trip, which lasted almost 6 hours, was most impressive and allowed participants to have a thorough look into the operation of one of the biggest jet-fighter producers in the country.

University of Alabama

The October 28 meeting, with 20 persons present, was called to order by Chairman Richard J. Berman, who introduced the speaker of the evening, Major G. I. Gore, U.S.A.F.

Major Gore's talk on "The Berlin Air Lift" included an interesting description of the technical problems involved. Inasmuch as the speaker took an active part in the air lift as a pilot, he was able to give first-hand details of this operation. He gave credit to the skilled pilots for much of the success of the undertaking. The Military Air Transport Service accomplished the mission against great obstacles. Problems of maintenance, traffic control, and technical details were discussed at length.

A question and answer period, which followed the talk, produced a lively discussion.

Polytechnic Institute of Brooklyn

Arthur Barazotti, *Secretary*

Two films were shown at the October 21 meeting. These were *Harnessed Lightning* and *Little Henry*. Chairman Fritz Blomback led the meeting; 47 students were present.

▶ At the November 11 meeting, attended by 40 student members, Frederick Stanley Shaw, Associate Professor of Applied Mechanics, presented a brief introduction to the film, *Structural Fatigue and Air Safety*.

Professor Shaw spoke on the problems faced in industry by the stress analysts who must concern themselves with wing vibration experienced in flight, as well as the plane-carrying abilities of the same wings. It is possible, he stated, for a wing to meet static-testing requirements and yet fail dynamically as a result of overly high flight vibrations, a problem of seriousness because of its association with the problem of fatigue.

Professor Shaw then added a note of caution to the prospective engineer when he said, "...engineering problems at school and in practice are somewhat different. At school, solutions to these problems are generally available, while in practice they are not."

The film, which followed, showed one of the best existing techniques developed for testing the performance of aircraft structures, both statically and dynamically.

Chairman Blomback presided.

The Catholic University of America

William Elsen, *Secretary*

At the November 13 meeting of The Catholic University of America Student Branch of the I.A.S., an informative talk on aeroballistic research was given by Dr. Herman Kurzweg, Head of Aeroballistics at the Naval Ordinance Laboratory. During the past war, he was one of Germany's top men in supersonics and designed a wind tunnel that is now in this country.

Dr. Kurzweg showed how the once unrelated sciences of aeronautics and ballistics have become more and more closely related over the years and might soon combine into one science. He described the high-Mach wind tunnels and firing ranges being used at the present time to determine the behavior of projectiles at supersonic speeds. From this equipment and study, it is hoped to solve the problems presented by high-speed flight. He supplemented his talk by slides of some of the equipment and tests employed in the work.

Earl Erickson, Chairman, presided at the meeting with 20 members present.

▶ Preston Weaver, of the National Bureau of Standards, was the guest speaker at the December 3 meeting of the Student Branch of the I.A.S. Mr. Weaver described the work being done in determining the remaining life of an airplane structure in the normal use for which it was intended. It is done by recording the number of times various accelerations are exceeded in flight and comparing them with the number of times required to cause failure as obtained from laboratory tests. New equipment has been developed for this study, and the results appear to be fairly accurate.

Earl Erickson, who presided at the meeting of 18 members, thanked the members who attended the funeral of Prof. Louis Crook, Head of the Aeronautical Engineering Department here at Catholic University, who died suddenly on November 19. Mr. Crook was one of the most prominent men in the aeronautical world and had been head of the department since 1935.

It was decided to draw up a petition to have the new engineering building, which is to be constructed here shortly, named after Professor Crook. This petition would be submitted to the proper authorities after a large number of signatures had been obtained.

Iowa State College

The first meeting of the 1952–1953 scholastic year was called to order on October 29 by Vice-Chairman Duane Schoelerman. Twenty-five students were present.

At the conclusion of the business meeting, Prof. C. N. Sanford, Faculty Adviser, showed three movies. They were entitled *Science of Flight*, *Constitution*, and *P-80 Shooting Star*.

University of Maryland

R. J. Vendemia, Jr.
Secretary-Treasurer

The October 15 meeting of the University of Maryland Student Branch was called to order by Chairman Leonard Tinnanoff with 15 student members present.

Announcement was made at this first meeting of the 1952–1953 school year of the following awards for last year: (1) the technical award for the highest grades in aeronautical engi-

AMPHENOL
Symbol of
DEPENDABILITY
Just as the citizens of our nation place their confidence in the dependability and strength of our air power, so do the designers and builders of our air power depend on AMPHENOL for quality and dependable electronic components. The AMPHENOL Trademark on any electronic cable or connector symbolizes hours of painstaking research, development and carefully controlled manufacture. Specify AMPHENOL for positive assurance of receiving the very utmost in dependable service from the cables and connectors designed into electronic equipment.
AMERICAN PHENOLIC CORPORATION
4 chicago 50, illinois
AMPHENOL
1
2
3
5

neering subjects to Thomas Hainsworth, and (2) the award for the best I.A.S. student paper to William Bissell for his report entitled "Use of the Ballistics Range for Study of Supersonic Aerodynamics."

The speaker of the evening was William Besserer, Chief Project Engineer of the "Bumble-Bee Project," at The Johns Hopkins University Applied Physics Laboratory, Silver Spring, Md. The title of his talk was "Research and Development of Guided Missiles."

Explaining that much of the accomplished results already achieved with guided-missile research could not be revealed because of security restrictions, Mr. Besserer directed his talk toward the basic development of various missiles instead. He explained the many problems to be overcome in successfully producing these pilotless "flying brains." Using several models of missiles to aid his talk, Mr. Besserer further expounded on the structures, aerodynamics, power plants, and electronic devices of guided missiles, pointing out the relationships, advantages, and disadvantages of the many components.

The Student Branch here at the University of Maryland, having already completed bookings of films for the entire semester, has adapted a policy of showing motion-picture films once a week. Already viewed this year were such films as *The Banshee*, *History of Lighter Than Air Rigid Airships*, *Building the B-29*, *Jet Test*, and *Flight Log*.

University of Michigan

Hsueh-Ping Wu
Secretary-Treasurer

The first meeting of the year was held on October 29 at the East Engineering Building. The following officers were elected for the 1952 fall semester: Chairman, Warren H. File; Vice-Chairman, Arthur Eugene Sotak; and Secretary-Treasurer, Hsueh-Ping Wu. The Faculty Adviser is Prof. Wilbur C. Nelson.

▶ The second meeting was held on November 19 at the Michigan Union. Our guest speaker was Arthur Lowell, of McDonnell Aircraft Corporation. Mr. Lowell is Chief of the Aerodynamics-Guided Missile Division of that company. Mr. Lowell spoke on the barriers to supersonic flight. He discussed the three important barriers—namely, the sonic barrier, thermal barrier, and cosmic barrier. A general discussion with questions from the audience followed the speech. Refreshments were served to 38 I.A.S. Student Members and faculty members who were present at the meeting.

North Carolina State College

Mary Ellen Short, *Secretary*

Fifteen students met on November 10 under the Chairmanship of A. L. Bell to hear Captain V. M. Davis who is with the Research and Development Plant in the Nuclear Project at North Carolina State. Captain Davis presented an excellent group of Kodachrome slides, which began with his departure from San Francisco in November, 1949, continued through his occupation duty in Japan, and concluded with his return to the United States in September, 1951. Captain Davis gave a running commentary on the slides.

University of Notre Dame

Thomas Lindsay, *Secretary*

The Notre Dame Student Branch met on September 24 in the Aeronautical Engineering building, with 25 members present. Chairman Robert Sebold presided. This was the first meeting of the fall semester, and its purpose was to welcome the freshmen and introduce them to the department. F. N. M. Brown, Head of the Department of Aeronautical Engineering, welcomed them on behalf of the department. He congratulated them on their choice of a profession, not only because the need for aeronautical engineers is urgent, but also because the field is so interesting and challenging. After the meeting, Mr. Brown demonstrated the department's three-dimensional smoke tunnel.

Business discussed during the meeting included the coming banquet and the technical paper contest to be held in March.

▶ The second meeting of the fall semester of the Notre Dame Student Branch was held on October 8, with 23 members present and Chairman Bob Sebold presiding. Speaker for the evening was Dr. Frederick P. Jenks, Head of Lockheed's Guided Missiles Division. He described the organization of Lockheed's Engineering Department and the close cooperation between engineers and construction shop which produced the F-80 in 141 days. At the conclusion of his talk, he answered questions of interest to prospective engineers.

A film was shown, *Air Power is Peace Power*, produced by Eastern Air Lines. The film touched upon the history and the future of aviation, with Eddie Rickenbacker as narrator.

▶ Chairman Robert Sebold presided over the third meeting of the Notre Dame Student Branch on November 5. Seventeen members were present. Hank McGann reported that final arrangements were being made for the fall semester banquet, and the date was tentatively set for December 3.

Robert E. Grenau, of McDonnell Aircraft Corporation, spoke to the members on engineering opportunities at McDonnell. He also showed a film, *Blueprint For Your Future*, on the same subject.

The Pennsylvania State College

Frank A. Leader
Secretary-Treasurer

The first joint meeting of The Pennsylvania State College Student Branch of the I.A.S. with the local Student Branches of A.S.M.E. and S.A.E. was held on November 13 on the Penn State campus. A combined attendance of approximately 110 student and faculty members was present.

Our own Chairman, Max Schuster, called the meeting to order and, after a short business meeting, turned the chair over to M. C. Stone, from Allison Division of General Motors Corporation, guest speaker for the evening.

Mr. Stone's talk was entitled "Recent Engineering Developments in Jet Engines," in which he discussed the various types of jet engines and the modern equipment that is used in testing and developing them. Much of this was done by showing what Allison is building and the devices and machinery they employ. He passed out a large chart showing the required man-hours to start from the beginning, develop, and finally produce a propulsion unit. A short question period followed.

The University of Tulsa

Robert Wolfe
Secretary-Treasurer

The third meeting held on November 20 at the Petroleum Engineering Building, was called to order by Chairman E. H. Roberts, with a total attendance of 20 persons. Minutes of the last two meetings were read and approved.

A lengthy business meeting was held concerning all unfinished and new business. Final arrangements were made for the coming field trip on November 28 to Aero Design and Engineering Company of Bethany, Okla.

Plans were put together for the Engineering School's open house, which is to occur in March. Each student will be assigned a certain project to be carried out to completion for this opening.

A film, *Structures*, was shown which gave the problems in structures on the B-25 bomber. This was followed by a film from North American Aviation, Inc., on *This Is Air Power*.

The meeting was adjourned at 9:45 p.m.

▶ Thirteen members of Tulsa's Student Branch visited the Aero Design and Engineering Company at Bethany, Okla., on November 28. This company manufactures the "Aero Commander" airplane.

The members were escorted through the complete assembly process. Definite points of interest and construction were pointed out so that the students would see the most important factors of design. The plant design was arranged for the most efficient method of assembly, demonstrating the principles of time control and routing. Approximately 50 airplanes have been completed or are in the process of completion. There are orders to fill for the next 5 years at a production rate of two per week. The T.U. students enjoyed their visit and recommend it to all other I.A.S. groups in this vicinity.

West Virginia University

Charles R. Bartlett, *Secretary*

The meeting of October 15 was called to order by Chairman David Anderson. A discussion was held on the intramural sports program for engineers. The Branch decided to enter several events. A Walt Disney film entitled *Air Masses and Fronts* was shown. Ten students were present.

▶ The meeting of November 5 was called to order by Chairman Anderson. Much of the Branch business was discussed in detail, including the financial problem, the athletic program, and the coming General Engineering Society meeting on November 11, which is sponsored by this Student Branch. *Jet Test*, a film of the flight testing of the F-86 Sabre Jet, was shown. Eleven persons were in attendance.

▶ The meeting of November 19 was called to order by Chairman Anderson. Professor Leon Z. Seltzer, Head of the Department of Aeronautical Engineering, told the group of plans for a program to show the freshmen in the College of Engineering the aeronautical laboratories and facilities. Forty-one freshmen expressed their desire to attend this demonstration. Malcolm Ullock gave a short talk on "Insectonautics." A film entitled *Fight for the Sky* was shown. This was an Eighth Air Force combat film on the conquest of the sky over Europe during World War II. Thirteen students attended.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Elected to Associate Fellow Grade

Regier, Arthur A., B.S. in E.E., Head, Vibration & Flutter Branch, N.A.C.A., Langley A.F.B.

Transferred to Associate Fellow Grade

Pratt, Perry W., B.S.M.E., Ch. Engr., Pratt & Whitney Aircraft Div., United Aircraft Corp. (East Hartford).

Elected to MEMBER Grade

Bennett, Neill G., Dir. & Ch. Engr., Graviner Manufacturing Co.

Bennett, Norman H., B.E. in M.E., Engrg. Designer, Prelim. Design Unit, Boeing Airplane Co. (Seattle).

Fettis, Henry E., M.S., Mathematician, Flight Research Lab., Wright Air Development Center, Wright-Patterson A.F.B.

Foreman, Arthur S., B.A.Sc., Process Analyst, Consolidated Vultee Aircraft Corp. (Ft. Worth).

Gettel, Eugene M., B.Sc., Tech. Engr., General Electric Co. (Lockland).

Groth, Eric E., Ph.D., Design Specialist "A," Northrop Aircraft, Inc.

Hebberling, Fritz, D.Ing., Mech. Engr., E. I. du Pont de Nemours & Co., Inc.

Hyde, Rosalyn E., Stress Analyst, Republic Aviation Corp.

Jones, Clyde B., B.S. in M.E., Ch., Aero. Engrg., Hughes Aircraft Co.

Knausenberger, Georg E., Dr.Ing., Assoc. Prof., The Pennsylvania State College.

Lange, Hermann E., Dipl.Ing., Sr. Stress Analysis Engr., Consolidated Vultee Aircraft Corp. (San Diego).

Lundergan, C. Donald, M.S. in Nuclear Physics, Instructor in Aero. Engrg., Parks College of St. Louis University.

Madsen, Alfred P., B.S.A.E., Sr. Aerodynamics Engr., Consolidated Vultee Aircraft Corp. (Ft. Worth).

Magill, Gilbert, Pres., Rotor-Craft Corp.

Mathers, William D., B.S.M.E., Sales Engr., Aluminum Company of America (New York).

Parker, Jack S., B.S.M.E., Mgr., Remote Site, Aircraft Nuclear Propulsion Proj., General Electric Co. (Lockland).

Ramsen, John A., M.E., Aero. Research Scientist—Hydrodynamics, N.A.C.A., Langley A.F.B.

Sforzini, Robert A., B.S. in M.E., Test Facility Operations Engr., Marquardt Aircraft Co.

Sutter, Joseph J., B.S. in Aero., Research Engr., Lockheed Aircraft Corp. (Burbank).

Wadlin, Kenneth L., B.S., Aero. Research Scientist, N.A.C.A., Langley A.F.B.

Transferred to MEMBER Grade

Anderton, David A., B. of Ae.E., Engrg. Editor, *Aviation Week*, McGraw-Hill Publishing Co.

Bleviss, Zegmund O., Ph.D. in Aeronautics, Aerodynamics Research Engr., Douglas Aircraft Co., Inc. (Santa Monica).

Blose, Donald H., M.S., Proj. Control Engr., Guided Missiles Branch, Wright-Patterson A.F.B.

Coletti, Donald E., B.S. in Aero., Aero. Research Scientist, Aerodynamics, Langley Aeronautical Lab., N.A.C.A.

Covert, Eugene E., M.Sc. in Ae.E., Research Engr., Analysis & Research Group, Naval Supersonic Lab., Massachusetts Institute of Technology.

Cutler, M. Michael, M.Sc., Sr. Test Engr., Wright Aero. Div., Curtiss-Wright Corp.

De Lorenzi, Ezio P., A.E., Proj. Struct. Engr., Bell Aircraft Corp.

Dye, Fulton E., Jr., B.S., Asst. Research Aerodynamicist, Cornell Aeronautical Lab., Inc.

Goodell, Howard C., M.S. in Aero., Lt. Col., U.S.A.F.; Officer in Charge of research and new devel. branch, Field Command, Armed Forces Special Weapons Proj., Sandia Base (Albuquerque).

Gregg, Arthur B., Jr., B.Aero.E., Tech. Sales Engr. for Army Ord. & Air Force Contracts, General Electric Co. (Schenectady).

Grigsby, Carl E., B.S. in M.E. (Aero.), Aero. Research Scientist III, GS-11, N.A.C.A., Langley Aeronautical Lab.

Hirsch, Richard A., M.S. in Applied Math., Sr. Struct. Engr., Aircraft Armaments, Inc.

Hsu, Chieh-Su, Ph.D., Tech. Engr., in charge of Applied Mechanics Group, Engrg. Lab., I.B.M.

Jackson, Kenneth L., B.S., Capt., U.S.A.F.; Contracting Officer, A.R.D.C., Lackland A.F.B.

Kirk, Jack L., B.S., Exec. Engr., Staff Asst., Beech Aircraft Corp. (Wichita).

Langen, William A., Jr., B. of Ae.E., Design Engr., Goodyear Aircraft Corp.

Lawyer, John E., Maj., U.S.A.F.; Ch., Flight Control Unit, All Weather Sect., Directorate of Flight and All Weather Testing, Wright Air Development Center.

Maeder, Paul F., Ph.D. in Engrg., Assoc. Prof. of Engrg., Brown University.

Maxwell, Norman E., B.S. in Ae.E., Sr. Aerodynamics Engr., Consolidated Vultee Aircraft Corp. (Pomona).

McCormick, Barnes W., Jr., M.S. in Ae.E., Research Assoc., Ord. Lab., The Pennsylvania State College.

Moos, Henry, Mech. Design Engr., Engineering & Research Corp.

Ormsbee, Allen I., M.S., Research Physicist, Missile Aerodynamics Dept., Research & Devel. Lab., Hughes Aircraft Co.

Pine, Cecil C., Engrg. Sect. Head for Flight Test, Flight Research Dept., Sperry Gyroscope Co., Div., The Sperry Corp.

Polovkas, Vincent G., M.Sc. in Engrg., Struct. Engr., Consolidated Vultee Aircraft Corp. (Ft. Worth).

Smith, Maurice H., M. of Library Sc., Research Assoc. in charge of Tech. Libraries, James Forrestal Research Center, Princeton University.

Steffen, John W., B.Sc., Lt. & Aircraft Maint. Officer, Fleet Air Wing Four-Staff, U.S.N., Naval Air Station (Whidbey Island).

Surber, True E., B.S.A.E., Aerodynamicist "B," North American Aviation, Inc. (Los Angeles).

Thomas, Edwin L., B.S. in Ae.E., Engrg. Supvr., Fuselage Struct. Group Leader, Temco Aircraft Corp. (Dallas).

Walker, Donald P., A.E., Asst. Ch., Aircraft Maint. Sect., Hq., MATS, U.S.A.F. (Washington, D.C.).

Wallace, Richard E., A.E., Sr. Research Engr., University of Wichita.

Williams, James W., B.S., Exec. Officer, Coast Guard Aircraft Repair & Supply Base (North Carolina).

Elected to Associate Member Grade

Cantrell, William A., Aircraft Maint. Supvr., Atlantic Div., Military Air Transport Service, 15th A.T.S., Westover A.F.B.

Faneuf, Leston, B.S., Asst. Gen. Mgr., Secretary & Treasurer, Bell Aircraft Corp.

Foster, Murray, Jr., Admin. Asst. GS-9, Hq., Air Research & Development Command (Baltimore).

Mullin, Sam S., Bachelor of Laws, Pres. & Dir., Cleveland Pneumatic Tool Co.

Risner, Lorin W., Sales Engr., Larkin Engineering Co., Inc.

Tragham (Ingram), Alfred Ernest, Sr. Insp., Burndy Engineering, Inc.

Transferred to Associate Member Grade

Jordan, Paul K., B.S., Weight Analyst "A," North American Aviation, Inc. (Columbus).

Elected to Technical Member Grade

Biggs, Albert W., M.B.A., Jr. Engr. "A," Boeing Airplane Co. (Seattle).

Bloxsom, Daniel E., Jr., B.A., Engr. 1, Gas Dynamics Facility, ARO, Inc. (Tullahoma).

Sisto, Fernando, Sc.D., Asst. Proj. Engr., Wright Aero. Div., Curtiss-Wright Corp.

Stempnitzky, Maurice, Sr. Engr. Draftsman, The Glenn L. Martin Co.

Weaver, Charles W., Jr., Jr. Stress Engr., Prewitt Aircraft Co.

The Finest in Testing

3,000,000 LBS.

The largest mechanically driven Universal Testing Machine in the country is now under construction in our shops. This giant 3,000,000 Pound Tension, Compression, Traverse and Fatigue Testing Machine incorporates the last word in Testing Technique. After erection in a large government research laboratory its many new features will greatly assist in reaching new horizons in the research field.

STANDARD UNIVERSAL AND COMPRESSION TESTING MACHINES are available in sizes from 1000 to 1,000,000 pounds, all with precision lapped ram or separate hydraulic weighing capsules. Three lines of machines available—priced to meet your budget.

ACCESSORIES—Stress-Strain Recorder, Extensometers, grips, and all others.

SPECIAL TESTING MACHINES manufactured to meet your specifications in cable testing, torsion and others.

THRUST-LOAD WEIGHING SYSTEMS—Pneumatic, Hydraulic, Electrical.

STRAIN GAGE EQUIPMENT
Our Static Type A Indicators incorporate features new to this field.

SWITCHING & BALANCING UNITS—Static and high speed switching equipment up to 200 gages per second.

STRAIN GAGE BOND CHECKER—checks your strain gage application in 10 seconds.

HUGGENBERGER INSTRUMENTS
We are U. S. A. representatives for Huggenberger equipment.

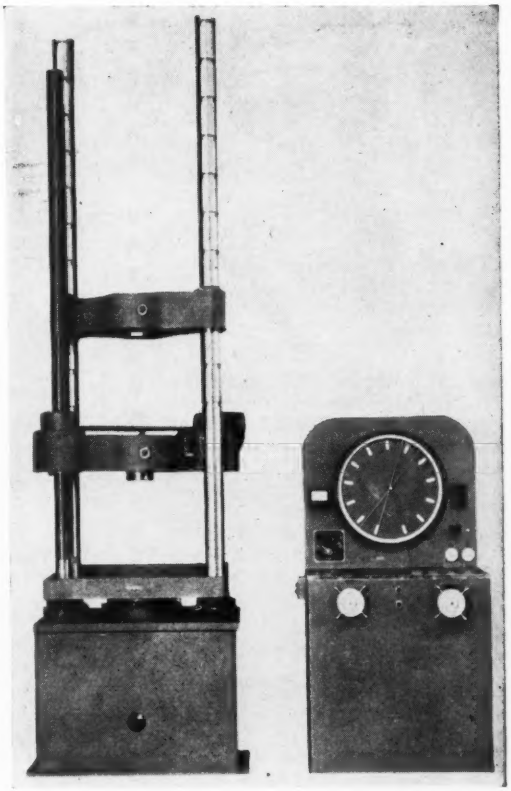
OSCILLOGRAPHS—6 to 60 Channels—Amplifiers 4 to 8 Channels, Bridge Balance Units.

XY RECORDERS—All types—1 to 48 Channels.

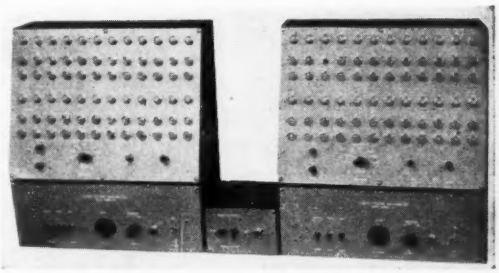
HIGH SPEED CATHODE RAY RECORDERS—paper speeds up to 150″ per second, with 6″ wide paper—up to 8 independent traces.

DEVELOPING & DRYING EQUIPMENT for paper and film, available in combination and automatic units, up to 18″ wide.

PHOTOELASTIC MACHINES—Finest for Laboratory Work.



Standard Testing Machine

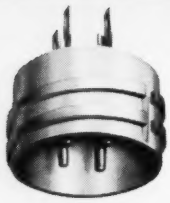


High Speed Switching and Balancing Unit

YOUNG TESTING MACHINE COMPANY

752 Lancaster Avenue, Bryn Mawr, Pa. • **Phone: Bryn Mawr 5-3520**

CANNON PLUGS *for hermetic sealed applications*



KH

RKH

HERMETIC SEALED Type RKH Plugs and KH Receptacles mate with their corresponding Cannon RK and K standard fittings. The basic construction of fused vitreous insulation around the contacts is same as GS type. Shell materials and finish are likewise similar. Various types of flange or hex-bulkhead styles may be made to order.

Refer to KH-1 Section in K Bulletin.

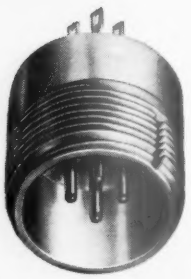
SUB-MINIATURE receptacles of the new Cannon "U" Series are used on miniature switches, relays, transformers, amplifiers, and other sealed components, requiring a true hermetic seal or a connector of sub-miniature size with performance superiority.

"U" plugs have a steel shell and "SILCAN*" insulator, cable relief and moisture resistant sleeve.

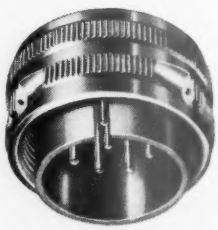
Bayonet-type locking means prevents vibration failure. Rated 1700v. d.c.; 5a. Available in 3, 6, and 12 contact arrangements with one plug style and two receptacles.

**Cannon Electric's special silicone resilient material.*

Refer to U-2 Bulletin



GS02



GS06

GS Types mate with standard AN(MIL) types. These highly successful hermetically sealed plugs (GS06) and receptacles (GS02) pioneered this field and are top quality fittings. Fused vitreous insulation provides a true hermetic seal for relays, position indicators, etc. Shells are steel, finished in cadmium plate and bleached Iridite; coupling nut on plug is natural finish Dural. Eyelet or solder pot terminals.

Built to resist thermal shock, −300°F. to +600°F., surpassing MIL Spec. GS02 Types will withstand operation temperatures 400°F. to 600°F., and pressures as high as 200 to 900 psi; specials to 7500 psi. GS Types approximate AN voltage and current ratings. Wide range of AN layouts available.

See GS-3 section in AN-8 Bulletin for details.

COMING: TYPE "DH" HERMETIC SEALED CONNECTORS SIMILAR TO PRESENT DA-15P

CANNON ELECTRIC

CANNON ELECTRIC

Since 1915

Factories in Los Angeles, Toronto, New Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Co., Dept. B-105, P.O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif.

Transferred to Technical Member Grade

Arthur, Paul D., Ph.D. (Aeronautics), Operations Analyst, Hq., U.S.A.F. (Pentagon).

Besonis, Algimantas, B.S. in Ae.E.

Conti, Gino, Methods Analyst, Republic Aviation Corp.

Dienst, William L., M.S., Capt. & Sr. Pilot, U.S.A.F.; Proj. Engr., Flight Test Center, Edwards A.F.B.

Ellis, Charles W., III, M.S. in Ae.E., Dynamics Analyst, Kaman Aircraft Corp.

Germano, Bruno J., Draftsman, Grumman Aircraft Engineering Corp.

Gonzalez, Alex, Aerodynamicist, North American Aviation, Inc. (Los Angeles).

Gross, Joseph E., B.S., Struct. Engr. "C," McDonnell Aircraft Corp.

Hickman, Billy J., B.S. in Ae.E., 2nd Lt., U.S.A.F.; Aero. Engr., Griffis A.F.B.

Holub, Carlton J., B.S. in Ae.E., Design Engr., Production Engineering Dept., Goodyear Aircraft Corp.

Ilgen, Paul R., B.S., Jr. Engr.—Design Draftsman, Chance Vought Aircraft Div., United Aircraft Corp.

Jensen, James R., B.S.M.E., Jr. Engr., Hiller Helicopters.

Khanna, Ramesh, B.S.E. (Aero.).

Kooharian, Anthony, Sc.B. in Engrg., Student, Grad. Div. of Applied Math., Brown University.

Manthey, Stuart W., B.S. in Ae.E., Engr. "C," Airplane Engrg. Dept., McDonnell Aircraft Corp.

Miller, Raymon M., B.S. in Ae.E., Field Service Rep., Douglas Aircraft Co., Inc. (Santa Monica).

Mitchell, Willard L., B.S.M.E., 1st Lt., U.S.A.F., Flight Test Engr., Edwards A.F.B.

Morgan, Roy M., Jr., Jr. Engr., Mech. Test Lab., Guided Missiles Div., Consolidated Vultee Aircraft Corp. (Pomona).

Muramatsu, James S., Design Engr., North American Aviation, Inc. (Los Angeles).

Norga, Leon J., B.S. in Ae.E., Ch. Insp., Handley Brown Heater Co.

Peasley, Donald L., B.S.Ae.E., Stress Analyst "C," North American Aviation, Inc. (Los Angeles).

Scambos, Ernest T., B.S., Test Engr., Exp. Test Dept., Wright Aero. Div., Curtiss-Wright Corp.

Snell, William J., B.A.

Sutrisno, A.

Tedeschi, Louis J., S.M., Aerodynamicist, Kaman Aircraft Corp.

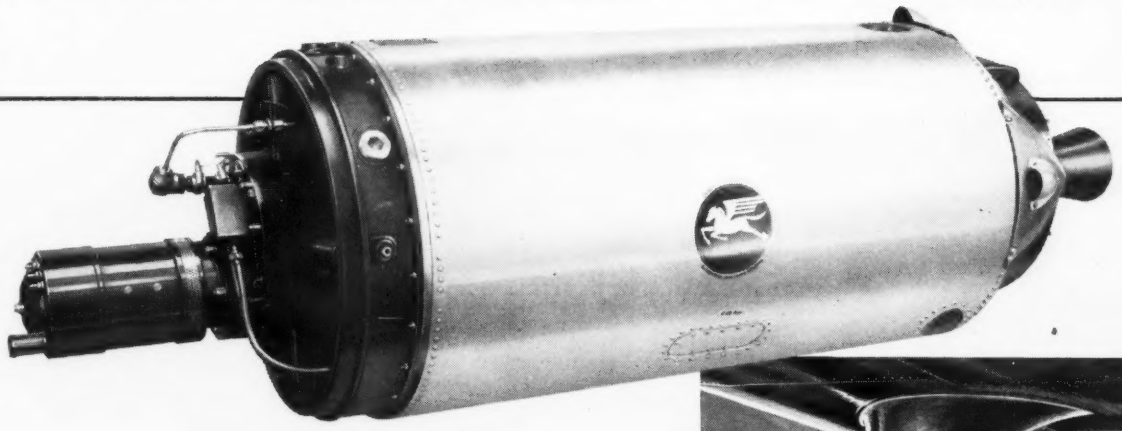
Way, James B.

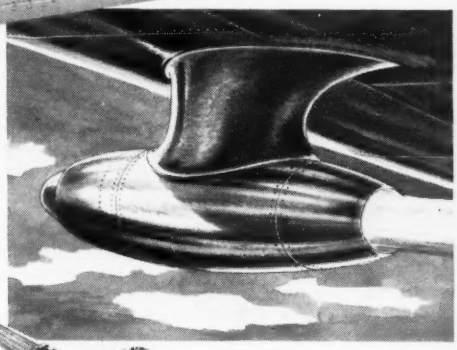
Young, Daniel H., III, B.S. in Ae.E., Aerodynamicist, North American Aviation, Inc. (Columbus).

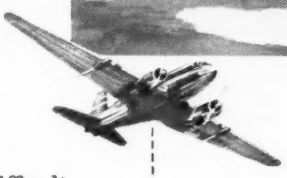
NEW HIGH IN SPECIALIZED

POWER

3 LBS. THRUST FROM 1 LB. WEIGHT







The J-44 Monocoque Turbo-Jet Engine... Designed and Built by Fairchild

One of the most compact engines in its power class ever produced is the Fairchild J-44 Monocoque Turbo-Jet. Only 72 inches in length, 22 inches in diameter and weighing only 300 pounds, the J-44 delivers a thrust of 1000 pounds.

Another example of a Fairchild design which met difficult and exacting specifications, the J-44 typifies the creative engineering ability of the Fairchild Engine Division.

Right now, the Fairchild J-44 Monocoque Turbo-Jet is being produced exclusively for the Armed Services. When conditions permit, this mighty midget will become available to boost payloads and lower operating costs of airline transports and other aircraft.

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Engine Division
FARMINGDALE, N. Y.

Aircraft Division
Hagerstown, Md.

Guided Missiles Division
Wyandanch, L. I., N. Y.

More and more POWER developments for America's Armed Forces

I.A.S. Preprints

Preprints of Annual Summer Meeting Papers Currently Available

		Member Price	Nonmember Price
388	The Effect of Propeller Control Parameters on Gas-Turbine Power Ratings and Flight Efficiency—R. C. Treseder, M. Brooks, and J. R. Kessler.	$0.35	$0.75
387	Analysis of Redundant Structures by the Method of Elastic Poles—A. F. Ensrud.	0.35	0.75
386	The Shock Ignition Engine—Frank F. Rand, Jr.	0.35	0.75
385	Effect of Creep on Column Deflections—T. P. Higgins, Jr.	0.50	0.85
384	Wing-Body Interference Effects on the Tail Contribution to the Damping-in-Roll of Supersonic Missiles—Harold F. Steinmetz.	0.35	0.75
383	Slender-Body Theory: Review and Extensions—Mac C. Adams and W. R. Sears.	0.65	1.00
382	The Airplane Growth Factor and How to Control It—I. H. Driggs.	0.35	0.75
381	Cockpit Design and Safety—William I. Stieglitz.	$0.50	$0.85
380	New Components for Air-Frame Construction—Report of Progress—John F. Faulkner and John H. Alden.	0.50	0.85
379	Fundamental Aspects of an Hydraulic-Type-Powered Flight Control System—Harold M. DeGroff, Ray C. Binder, John G. Truxal, and J. Robert Burnett.	0.65	1.00
378	Liquid-Coupled Regenerators for Turboprops—A. L. London and W. M. Kays.	0.50	0.85
377	Structural Analysis of Swept, Low Aspect Ratio, Multispar Aircraft Wings—Hans Schuerch.	0.50	0.85
376	Statistical Aspects of Dynamic Loads—Y. C. Fung.	0.65	1.00
375	Theoretical Determination of the Minimum Drag of Airfoils at Supersonic Speeds—Robert T. Jones.	0.50	0.85

Other Preprints of Papers Currently Available

369	Criteria for the Design, Assessment, and Control of Icing Protection Systems—D. Fraser, K. G. Pettit, and E. H. Bowler.	$0.35	$0.75
365	The Effect of Nonuniform Surface Temperature on the Transient Aerodynamic Heating of Thin-Skinned Bodies—A. E. Bryson and R. H. Edwards.	0.35	0.75
364	The Air-Line Pilots Look at Safety—W. W. Moss.	0.50	0.85
363	Flutter Analysis of Complex Airplanes by Experimental Methods—E. Berkeley Kinnaman.	0.50	0.85
362	Performance Data and Operating Experience of a Pressure-Jet Helicopter—Igor B. Bensen.	0.50	0.85
361	Storm and Clear Air Turbulence—An Analysis of the Problem and a Search for Solution—A. F. Merewether and F. C. White.	0.35	0.75
360	Radomes and Aircraft Design—Ernest W. Schlieben.	0.65	1.00
359	Simplified Laminar Boundary-Layer Calculations for Bodies of Revolution and for Yawed Wings—N. Rott and L. F. Crabtree.	0.65	1.00
358	Design Limitations on Aircraft Antenna Systems—J. V. N. Granger.	0.35	0.75
357	On Weak Interaction of Strong Shock and Mach Waves Generated Downstream of the Shock—Boa-Teh Chu.	0.65	1.00
356	Correlation of Some Longitudinal Dynamic Stability Characteristics of a Bell Helicopter from Theory and Flight Tests—Edward Seckel.	$0.35	$0.75
354	An Analysis of the Effect of a Power Boost System on Wing-Torsion Control Surface Flutter—Robert H. Barnes.	0.35	0.75
353	Creep Buckling of Columns—Charles Libove.	0.50	0.85
352	Cross-Country Soaring Criteria Based on Thermal Strength—B. H. Carmichael.	0.35	0.75
351	Visualization of Flow Fields by Use of a Tuft Grid Technique—John D. Bird.	0.35	0.75
350	The Effects on Dynamic Lateral Stability and Controllability of Large Artificial Variations in the Rotary Stability Derivatives—R. O. Schade, O. B. Gates, Jr., and J. L. Hassell, Jr.	0.50	0.85
349	Diffuser Efficiency of Free-Jet Supersonic Wind Tunnels at Variable Test Chamber Pressure—Rudolf Hermann.	0.50	0.85
348	Boundary-Layer Studies on a Sailplane—August Raspet.	0.50	0.85
347	The Calculations of Spanwise Loadings for Oscillating Airfoils by Lifting-Line Techniques—M. A. Dengler and Martin Goland.	0.50	0.85
346	Reduction of Gun-Gas Explosion Hazard in Combat Aircraft—J. J. Horan, J. R. Onderdonk, and E. Witkin.	0.50	0.85

Preprints should be ordered by number from:

Preprint Department, Institute of the Aeronautical Sciences

2 East 64th Street, New York 21, N.Y.

CORPORATE MEMBERS

OF THE

INSTITUTE OF THE AERONAUTICAL SCIENCES

ACADEMY OF AERONAUTICS, INC.
ADAMS RITE MANUFACTURING COMPANY
AEROJET DIVISION, THE GENERAL TIRE & RUBBER COMPANY
AEROLAB DEVELOPMENT COMPANY
AERONCA MANUFACTURING CORPORATION
AEROPRODUCTS - ALLISON DIVISION, GENERAL MOTORS CORPORATION
AEROQUIP CORPORATION
AGAWAM AIRCRAFT PRODUCTS, INC.
AIRBORNE ACCESSORIES CORPORATION
AIRBORNE INSTRUMENTS LABORATORY, INC.
AIRCRAFT RADIO CORPORATION
AIRESEARCH MANUFACTURING COMPANY, DIVISION OF THE GARRETT CORPORATION
ALLIS-CHALMERS MANUFACTURING COMPANY
ALUMINUM COMPANY OF AMERICA
AMERICAN AIRLINES, INC.
AMERICAN BOSCH CORPORATION
AMERICAN HELICOPTER COMPANY, INC.
AMERICAN PHENOLIC CORPORATION
AMERICAN STEEL & WIRE COMPANY
ANDERSON, GREENWOOD & COMPANY
ARDE ASSOCIATES
ASSOCIATED AVIATION UNDERWRITERS
ATLAS SUPPLY COMPANY
AVIATION ENGINEERING CORPORATION
BAKER STEEL & TUBE COMPANY
BEECH AIRCRAFT CORPORATION
BELL AIRCRAFT CORPORATION
BENDIX AVIATION CORPORATION
- BENDIX INTERNATIONAL DIVISION
- BENDIX PRODUCTS DIVISION
- BENDIX RADIO DIVISION
- ECLIPSE-PIONEER DIVISION
- FRIEZ INSTRUMENT DIVISION
- SCINTILLA MAGNETO DIVISION

THE BG CORPORATION
BOEING AIRPLANE COMPANY
- SEATTLE DIVISION
- WICHITA DIVISION

BOOZ, ALLEN & HAMILTON
BREEZE CORPORATIONS, INC.
THE BRISTOL AEROPLANE COMPANY OF CANADA LIMITED
BROOKS AND PERKINS, INC.
CAL-AERO TECHNICAL INSTITUTE
CALIFORNIA PANEL & VENEER COMPANY
CANADAIR LIMITED
THE CESSNA AIRCRAFT COMPANY
CHASE AIRCRAFT COMPANY, INC
THE CHASE NATIONAL BANK OF THE CITY OF NEW YORK
THE CLEVELAND PNEUMATIC TOOL COMPANY
CLIFFORD MANUFACTURING COMPANY, DIVISION OF STANDARD-THOMSON CORPORATION
CONSOLIDATED VULTEE AIRCRAFT CORPORATION
- FORT WORTH DIVISION

CONSULTANTS & DESIGNERS, INC.
CONTINENTAL MOTORS CORPORATION
CORNELL AERONAUTICAL LABORATORY, INC.
CORNELL UNIVERSITY
CURTISS-WRIGHT CORPORATION
- PROPELLER DIVISION
- WRIGHT AERONAUTICAL DIVISION

DOAK AIRCRAFT COMPANY, INC.
DOELCAM CORPORATION
DOUGLAS AIRCRAFT COMPANY, INC.
- EL SEGUNDO PLANT
- LONG BEACH PLANT
- SANTA MONICA PLANT
- TULSA DIVISION

THE DOW CHEMICAL COMPANY, MAGNESIUM DIVISION
DZUS FASTENER COMPANY, INC.
EASTERN AIR LINES, INC.
EATON MANUFACTURING COMPANY
EDO CORPORATION
ELASTIC STOP NUT CORPORATION OF AMERICA
ELECTROL INCORPORATED
ESSO STANDARD OIL COMPANY
ETHYL CORPORATION
FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
- FAIRCHILD AERIAL SURVEYS, INC.

FAIRCHILD ENGINE AND AIRPLANE CORPORATION
- AL-FIN DIVISION
- FAIRCHILD AIRCRAFT DIVISION
- FAIRCHILD ENGINE DIVISION
- FAIRCHILD GUIDED MISSILES DIVISION
- STRATOS DIVISION

FIRESTONE TIRE & RUBBER COMPANY OF CALIFORNIA
FLETCHER AVIATION CORPORATION
FLIGHT REFUELING, INC.
- FLIGHT REFUELLING (CANADA) LTD.

FLIGHT SAFETY FOUNDATION, INC.
GENERAL ELECTRIC COMPANY
- AIRCRAFT GAS TURBINE DEPARTMENT
- AVIATION DEPARTMENT

G. M. GIANNINI & COMPANY, INC.
GLOBE CORPORATION, AIRCRAFT DIVISION
THE B. F. GOODRICH COMPANY
THE GOODYEAR TIRE & RUBBER COMPANY
GRUMMAN AIRCRAFT ENGINEERING CORPORATION
W. & L. E. GURLEY
HARVEY MACHINE COMPANY, INC.
INDUSTRIAL SOUND CONTROL
INSURANCE COMPANY OF NORTH AMERICA COMPANIES
THE INTERNATIONAL NICKEL COMPANY, INC.
INTERNATIONAL TELEPHONE & TELEGRAPH CORPORATION
IRVING AIR CHUTE COMPANY, INC.
JACK & HEINTZ, INC.
JOHNS-MANVILLE SALES CORPORATION
CORYDON M. JOHNSON COMPANY, INC.
EARLE M. JORGENSEN COMPANY
THE M. W. KELLOGG COMPANY
WALTER KIDDE & COMPANY, INC.
KOLLSMAN INSTRUMENT CORPORATION
LAVELLE AIRCRAFT CORPORATION
LEAR INCORPORATED
THE LIQUIDOMETER CORPORATION
LOCKHEED AIRCRAFT CORPORATION
- GEORGIA DIVISION
- LOCKHEED AIRCRAFT SERVICE, INC. (SUBSIDIARY)

LOEWY CONSTRUCTION COMPANY, INC.
LONGINES-WITTNAUER WATCH COMPANY, INC.
MARMAN PRODUCTS COMPANY, INC.
MARQUARDT AIRCRAFT COMPANY
THE GLENN L. MARTIN COMPANY
McDONNELL AIRCRAFT CORPORATION
MELETRON CORPORATION
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY
- AERO DIVISION

NATIONAL CREDIT OFFICE, INC.
NORTH AMERICAN AVIATION, INC.
NORTHROP AIRCRAFT, INC.
PAN AMERICAN WORLD AIRWAYS, INC.
THE PARKER APPLIANCE COMPANY
PESCO PRODUCTS DIVISION, BORG-WARNER CORPORATION
PHILLIPS PETROLEUM COMPANY
PIASECKI HELICOPTER CORPORATION
THE PURE OIL COMPANY
RADIOPLANE COMPANY
REPUBLIC AVIATION CORPORATION
E. V. ROBERTS AND ASSOCIATES
A. V. ROE CANADA LIMITED
JOHN A. ROEBLING'S SONS COMPANY
ROHR AIRCRAFT CORPORATION
PAUL ROSENBERG ASSOCIATES
SCHRILLO AERO TOOL ENGINEERING COMPANY
SEABOARD & WESTERN AIRLINES, INC.
SHELL OIL COMPANY
SIMMONDS AEROCESSORIES, INC.
SOCONY-VACUUM OIL COMPANY, INC.
SOLAR AIRCRAFT COMPANY
SPERRY GYROSCOPE COMPANY DIVISION OF THE SPERRY CORPORATION
STANDARD OIL COMPANY OF CALIFORNIA
STANDARD OIL COMPANY (INDIANA)
THE STEEL PRODUCTS ENGINEERING COMPANY
STURGESS, INC.
SUMMERS GYROSCOPE COMPANY
TELECOMPUTING CORPORATION
THE H. I. THOMPSON COMPANY
THOMPSON PRODUCTS, INC.
TINNERMAN PRODUCTS, INC.
TOOLKO ENGINEERING COMPANY
TRANS WORLD AIRLINES, INC.
TURBO PRODUCTS, INC.
UNION CARBIDE AND CARBON CORPORATION
- BAKELITE COMPANY
- ELECTRO METALLURGICAL COMPANY
- HAYNES STELLITE COMPANY
- LINDE AIR PRODUCTS COMPANY
- NATIONAL CARBON COMPANY

UNITED AIR LINES, INC.
UNITED AIRCRAFT CORPORATION
- CHANCE VOUGHT AIRCRAFT DIVISION
- HAMILTON STANDARD DIVISION
- PRATT & WHITNEY AIRCRAFT DIVISION
- SIKORSKY AIRCRAFT DIVISION
- UNITED AIRCRAFT EXPORT CORPORATION
- UNITED AIRCRAFT SERVICE CORPORATION

UNITED STATES AVIATION UNDERWRITERS, INC.
VARD INC.
VICKERS, INC.
WESTERN GEAR WORKS
WESTINGHOUSE ELECTRIC CORPORATION
- AVIATION GAS TURBINE DIVISION
- INDUSTRIAL ELECTRONICS DIVISION
- SMALL MOTORS DIVISION

WESTON ELECTRICAL INSTRUMENT CORPORATION
WYMAN-GORDON COMPANY
YOUNG RADIATOR COMPANY

POWER

EEMCO

technical bulletin

WEIGHT

POWER

WEIGHT

Greater output per pound is the constant objective of the aircraft designer. EEMCO serves this goal by turning out new electric motors with increased power, decreased weight and all the required operating characteristics. This tough new lightweight for driving a compressor was built to the latest Army and Navy specifications. Operating on 27 volts D.C., it provides 3 horsepower under continuous duty at sea level, 2½ h.p. at 50,000 feet with duty cycle of ½ hour on—½ hour off. It weighs only 13½ pounds with integral gear box of 2¾ to 1 reduction.

Doubled plant capacity and new facilities enable EEMCO to keep pace with the growing need for these specialized designs. Today EEMCO motors and actuators are found on virtually all U. S. Aircraft.

ELECTRICAL ENGINEERING & MANUFACTURING CORP.

4612 West Jefferson Boulevard
Los Angeles 16, California

3-514

Aeronautical Reviews

A Guide to the Current Literature of Aeronautical Research and Engineering

I. PERIODICALS AND REPORTS

Aerodynamics (*See also* Aeroelasticity; Missiles; Wind Tunnels & Research Facilities) 80
Boundary Layer & Thermoaerodynamics (*See also* Thermodynamics) 80
Fluid Mechanics & Aerodynamic Theory 81
Internal Flow 81
Performance (*See also* Airplane Design—Descriptions; Flight Testing; Gliders; Missiles; Rotating Wing Aircraft; Water-Borne Aircraft) .. 83
Stability & Control 83
Wings & Airfoils (*See also* Airplane Design—Wing Group) 83

Aeroelasticity (*See also* Aerodynamics; Flight Operating Problems; Wind Tunnels & Research Facilities) 86

Aeronautics, General 86

Air Transportation (*See also* Airplane Design; Airports; Laws & Regulations; Maintenance) 86

Airplane Design (*See also* Aerodynamics; Flight Testing; Instruments; Military Aviation; Production; Water-Borne Aircraft) 86
Air Conditioning & Pressurization ... 88
Descriptions 88
Fuel Tanks 89
Wing Group (*See also* Aerodynamics—Wings & Airfoils) 89

Airports (*See also* Air Transportation; Laws & Regulations) 89

Aviation Medicine (*See also* Flight Operating Problems; Airplane Design—Air Conditioning & Pressurization) 90

Computers (*See also* Electronics; Instruments; Sciences, General—Mathematics) 92

Education & Training 92

Electronics (*See also* Computers; Equipment—Electric; Instruments; Sciences, General—Physics) 92
Antennas 92
Circuits & Components 92
Communications (*See also* Meteorology; Navigation; Space Travel) 95
Electronic Controls 95
Electronic Tubes 95
Measurements & Testing (*See also* Materials—Testing) 95
Radar (*See also* Meteorology; Ordnance & Armament) 95
Transmission Lines 96

Equipment (*See also* Airplane Design; Computers; Instruments; Machine Elements; Materials; Power Plants; Production) 96
Electric 96
Hydraulic 96
Pneumatic 96

Flight Operating Problems (*See also* Air Transportation; Airports; Aviation Medicine; Maintenance; Meteorology) 96
Ice Prevention & Removal 96

Flight Safety & Rescue (*See also* Air Transportation; Laws & Regulations) 96

Flight Testing (*See also* Aerodynamics—Performance; Airplane Design; Power Plants; Wind Tunnels & Research Facilities) 96

Fuels & Lubricants (*See also* Power Plants; Thermodynamics; Sciences, General—Physics) 96

Gliders 99

Instruments (*See also* Airplane Design; Computers; Electronics; Equipment; Meteorology; Photography; Wind Tunnels & Research Facilities) 99

Laws & Regulations (*See also* Air Transportation; Airports; other specific subjects) 103

Lighter-Than-Air 103

Machine Elements (*See also* Equipment; Materials; Power Plants; Production) 103
Bearings (*See also* Fuels & Lubricants) 103

Maintenance (*See also* Air Transportation; Airplane Design—Descriptions; Airports; Materials; Structures) 103

Materials (*See also* Production; Sciences, General—Physics; Structures) 103
Ceramics & Ceramals 104
Corrosion & Protective Coatings 105
Metals & Alloys 106
Metals & Alloys, Ferrous 106
Metals & Alloys, Nonferrous 108
Nonmetallic Materials 108
Testing (*See also* Electronics—Measurements & Testing; Instruments; Wind Tunnels & Research Facilities) 111

Meteorology (*See also* Air Transportation; Aviation Medicine; Flight Operating Problems; Maintenance; Navigation) 111

Military Aviation (*See also* Airplane Design; Missiles; Ordnance & Armament; Rotating Wing Aircraft; Water-Borne Aircraft) 111

Missiles (*See also* Power Plants—Rocket; Space Travel; Wind Tunnels & Research Facilities) 112

Navigation (*See also* Electronics; Instruments; Meteorology) 112

Ordnance & Armament (*See also* Military Aviation) 112

Parachutes 113

Personal Flying 113

Photography (*See also* Instruments; Wind Tunnels & Research Facilities) 113

Power Plants (*See also* Equipment; Flight Testing; Fuels & Lubricants; Instruments; Materials; Production; Wind Tunnels & Research Facilities) 113
Jet & Turbine 113
Ram-Jet & Pulse-Jet 115
Reciprocating 115
Rocket (*See also* Missiles; Space Travel) 115

Production (*See also* Airplane Design; Equipment; Machine Elements; Materials; Military Aviation; Power Plants; Structures) 116
Metalworking 117
Tooling 117

Propellers 118

Reference Works 118

Research (*See* Wind Tunnels & Research Facilities)

Rotating Wing Aircraft 118

Sciences, General (*See also* Wind Tunnels & Research Facilities; other specific subjects)
Mathematics 120
Physics (*See also* Electronics; other specific subjects) 122

Space Travel (*See also* Missiles; Power Plants—Rocket) 125

Structures (*See also* Airplane Design; Materials; Production) 125
Theory & Analysis 125

Thermodynamics (*See also* Aerodynamics—Boundary Layer & Thermoaerodynamics; Power Plants; Sciences, General—Physics) 126

Water-Borne Aircraft 128

Wind Tunnels & Research Facilities (*See also* specific subjects) ... 128

II. BOOKS REVIEWED IN THIS ISSUE

Grundlagen der Aeromechanik und Flugmechanik. Arthur Pröll 133
Reviewed by Dr. August Raspet, Mississippi State College

Instrument Engineering. Vol. 1, Fundamentals. C. S. Draper, Walter McKay, and Sidney Lees 134
Reviewed by James E. Bevins, Eclipse-Pioneer Division, Bendix Aviation Corporation

Book Notes 135

Books, reports, and periodicals reviewed in this issue or in previous issues may be borrowed on 2-week loan without charge by individual or Corporate Members of the Institute in the U.S. and Canada. Members of The Paul Kollsman Lending Library who are not Members of the Institute may borrow books and, in special cases, other research material. Members of the I.A.S. may borrow also from the Engineering Societies Library through The Paul Kollsman Lending Library.

Photostatic copies of material in the Institute's libraries may be obtained at a cost of $0.30 to members and Corporate Members ($0.40 to nonmembers) for each 8½- by 11-in. print and $0.35 to members and Corporate Members ($0.45 to nonmembers) for each 11½- by 14-in. print, plus postage. A service charge of $1.00 is made to nonmembers of the I.A.S. Rates for *microfilm copies* will be sent on request.

Bibliographies on special subjects will be compiled at the rate of $2.50 per hour. *Translations* of technical literature from foreign languages may be obtained at $12 to $14 per 1,000 words, depending on the language. I.A.S. members receive a 20 per cent discount on bibliographies and translations.

Full information about library membership and facilities will be sent upon request to The Paul Kollsman Lending Library, 2 East 64th St., New York 21, N.Y.

Aerodynamics

Analysis of the Swimming of Long and Narrow Animals. Geoffrey Taylor. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1117, August 21, 1952, pp. 158–183, illus. 15 references. Generalization of aerodynamic and hydrodynamic principles and data; investigations with a circular cylinder in a fluid stream.

The Hydrodynamical Investigation of the Thickness of Windbreaks. Matsunosuke Iwasaki. *Kyushu University, Japan, Research Institute for Applied Mechanics, Reports*, Vol. 1, No. 3, July, 1952, pp. 85–106, illus. 10 references.

Boundary Layer & Thermoaerodynamics

Boundary-Layer and Wake Investigation in Supersonic Flow. J. Lukasiewicz and J. K. Royle. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2613*, 1952 (October, 1948). 22 pp., illus. 9 references. British Information Services, New York. $1.40.

On the Design of Airfoils in Which the Transition of the Boundary Layer is Delayed. Itiro Tani. (*Tokyo Imperial University, Aeronautical Research Institute, Report No. 250*, Vol. 19, No. 1, January, 1943.) *U.S., N.A.C.A., Technical Memorandum No. 1351*, October, 1952. 74 pp., illus. 49 references.

On the Stability of Laminar Boundary Layer Flow. Sin-I Cheng. *Princeton University, Aeronautical Engineering Laboratory, Report No. 211* (1952). 24 pp. 14 references.

On the Boundary Layer Equations in Hypersonic Flow and Their Approximate Solutions. Lester Lees. *Princeton University, Aeronautical Engineering Laboratory, Report No. 212*, September 20, 1952. 10 pp., illus. 8 references.

On the Determination of the Transition Point from Measurements of the Static Pressure Along a Surface. H. Wijker. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Report No. A. 1210*, 1951. 11 pp., illus. 20 references.

Revised Methods for Routine Calculations of Laminar and Turbulent Boundary Layers of Two dimensional Incompressible Flows. J. A. Zaat. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Report No. F. 79*, 1951. 12 pp., illus. 13 references.

The Measurement of Heat Transfer and Skin Friction at Supersonic Speeds. II—Boundary Layer Measurements on a Flat Plate at $M=2.5$ and Zero Heat Transfer. R. J. Monaghan and J. E. Johnson. *Gt. Brit., Aeronautical Research Council, Current Papers No. 64*, 1952 (December, 1949). 45 pp., illus. 5 references. British Information Services, New York. $1.80.

Experimental and Theoretical Studies of Area Suction for the Control of the Laminar Boundary Layer on an NACA 64A010 Airfoil. Albert L. Braslow, Dale L. Burrows, Neal Tetervin, and Fioravante Visconti. (*U. S., N.A.C.A., Technical Note Nos. 1905, 2112*, 1949, 1950.) *U. S., N.A.C.A., Report No. 1025*, 1951. 19 pp., illus. 14 references. Superintendent of Documents, Washington. $0.25.

Boundary Layer Control by Continuous Surface Suction or Injection. T. Paul Torda. *Journal of Mathematics and Physics*, Vol. 31, No. 3, October, 1952, pp. 206–213, illus. 5 references.

Note on Sir Geoffrey Taylor's Criterion for the Rate of Boundary-layer Suction at a Velocity Discontinuity. N. Gregory. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2496*, 1952 (May 9, 1947). 12 pp., illus. 3 references. British Information Services, New York. $0.90.

Aerodynamic Heating In High Speed Flight. M. A. Sulkin. *Aviation Age*, Vol. 18, No. 3, September, 1952, pp. 28, 29, illus. Problems arising from the thermal barrier.

Effect of Aerodynamic Heating on Fuel Systems. Julius Jonas. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 812*. 14 pp., illus. 5 references.

Laminar Boundary Layer on Cone in Supersonic Flow at Large Angle of Attack. Franklin K. Moore. *U.S., N.A.C.A., Technical Note No. 2844*, November, 1952. 34 pp., illus. 13 references.

Second Approximation to Laminar Compressible Boundary Layer on Flat Plate in Slip Flow. Stephen H. Maslen. *U.S., N.A.C.A., Technical Note No. 2818*, November, 1952. 38 pp., illus. 17 references.

On the Momentum Equation in Laminar Boundary-Layer Flow; A New Method of Uniparametric Calculation. B. Thwaites. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2587*, 1952 (December, 1947). 9 pp. 9 references. British Information Services, New York. $0.75.

Calculation of the Stability of the Laminar Boundary Layer in a Compressible Fluid on a Flat Plate with Heat Transfer. R. E. Van Driest. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 801–812, 828, illus. 16 references.

Lees-Lin theory applied; V-2 flight-temperature data illustrates use of stability results in missile aerodynamic heating analysis.

Readers' Forum: Simplified Laminar Boundary-Layer Calculations for Bodies of Revolution and for Yawed Wings—Errata. N. Rott and L. F. Crabtree. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, p. 851.

The Measurement of Skin Friction in a Turbulent Boundary Layer at a Mach Number of 2.5, Including the Effect of a Shock-Wave. W. F. Cope. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 215, No. 1120, November 6, 1952, pp. 84–99, illus. 13 references.

The Calculation of the Point of Turbulent-Boundary-Layer Separation on an N.A.C.A. 0018 Profile and the Determination of the Optimum Angle of Incidence. J. A. Zaat. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Report No. F. 89*, September 26, 1951. 30 pp., illus., folded charts and tables. 13 references.

Fluid Mechanics & Aerodynamic Theory

The Theory of Symmetrical Gravity Waves of Finite Amplitude. I. T. V. Davies. **II—The Solitary Wave.** B. A. Packham. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vols. 208, 213, Nos. 1095, 1113, September 24, 1951, June 24, 1952, pp. 475–486; 238–249, illus. 9 references.

Generalization of Boundary-Layer Momentum-Integral Equations to Three-Dimensional Flows Including Those of Rotating System. Arthur Mager. (*U.S., N.A.C.A., Technical Note No. 2310*, 1951.) *U.S., N.A.C.A., Report No. 1067*, 1952. 16 pp., illus. 18 references. Superintendent of Documents, Washington. $0.20.

Relaxation Time Effects in Gas Dynamics. J. C. Gunn. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2338*, 1952 (April, 1946). 44 pp., illus. 20 references. British Information Services, New York. $2.60. Three cases: flow in a wind tunnel; flow round an airfoil, without shock waves; flow through shock waves.

The Characteristics of Fuel Motion Which Affect Airplane Dynamics. E. W. Graham and A. M. Rodriquez. *Douglas Aircraft Company, Inc., Report No. SM-14212*, November 27, 1951. 52 pp., illus. 6 references.

Stability of Viscous Motion Between Parallel Planes for Finite Disturbances. D. Meksyn and J. T. Stuart. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1095, September 24, 1951, pp. 517–526, illus. 6 references.

Transforms for the Eddy-Diffusion of Clusters. L. F. Richardson. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1116, August 7, 1952, pp. 1–20, illus. 20 references.

On an Extension of Riemann's Method of Integration, with Applications to One-Dimensional Gas Dynamics. Geoffrey S. S. Ludford. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 499–510, illus. 6 references.

Readers' Forum: On the Stability of Laminar Flame Fronts. Martin Lessen. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 852, 864, illus. 4 references.

The Aerodynamic Drag of a Free Water Surface. J. R. D. Francis. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 206, No. 1086, May 7, 1951, pp. 387–406, illus. 23 references. Measurements in a 7.5-cm. by 7-m. tunnel in which winds up to 14 m. per sec. can be made.

An Experimental Study of the Pressure Variations in Standing Water Waves. R. I. B. Cooper and M. S. Longuet-Higgins. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 206, No. 1086, May 7, 1951, pp. 424–435, illus. 5 references.

Energy, Virtual Mass and Wave Drag for Compressible Flows. E. W. Graham and M. E. Graham. *Douglas Aircraft Company, Inc., Report No. SM-14211*, November 20, 1951. 11 pp., illus. 3 references.

On the Asymptotic Behaviour of Viscous Fluid Flow at a Great Distance from a Cylindrical Body, with Special Reference to Filon's Paradox. Isao Imai. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1095, September 24, 1951, pp. 487–516. 4 references.

The Pitching Moment Acting on a Body of Revolution Moving Under a Free Surface. Hartley L. Pond. *U.S., Navy Department, David W. Taylor Model Basin, Report No. 819*, May, 1952. 13 pp., illus. 12 references.

The Forces and Moments Acting on A Body Moving in an Arbitrary Potential Stream. William E. Cummins. *U.S., Navy Department, David W. Taylor Model Basin, Report No. 780*, September, 1952, 58 pp., illus. 13 references.

Application of the Linear Perturbation Theory of Compressible Flow about Bodies of Revolution. A. D. Young and S. Kirkby. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2624*, 1952 (September, 1947). 8 pp., illus. 9 references. British Information Services, New York. $0.65.

The Influence of the Boundary Layer on the Wave Resistance of a Ship. V. M. Lavrentieff. *U.S., Navy Department, David W. Taylor Model Basin, Translation No. 245*, April, 1952. 4 pp., illus.

Motion of a Cylinder Under the Surface of a Heavy Fluid. L. N. Sretensky. (*Moscow, Central Aero-Hydrodynamical Institute, Report No. 346*, 1938, pp. 3–27.) *U.S., N.A.C.A., Technical Memorandum No. 1335*, November, 1952. 37 pp., illus. 1 reference.

Two-dimensional Compressible Flow Past a Solid Body Symmetrically Placed in a Channel. P. V. Abdurahiman. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2443*, 1952 (October 29, 1947). 6 pp., illus. 2 references. British Information Services, New York. $0.55.

On a Solution of the Energy Equation for a Rotating Plate Started Impulsively From Rest. Ronald F. Probstein. *Princeton University, Aeronautical Engineering Laboratory, Report No. 213*, September 20, 1952. 12 pp. 8 references.

On the Calculation of Flow About Objects Traveling at High Supersonic Speeds. A. J. Eggers, Jr. *U.S., N.A.C.A., Technical Note No. 2811*, October, 1952. 25 pp., illus. 34 references.

Hypersonic Viscous Flow Over a Flat Plate. Lester Lees and Ronald F. Probstein. *Princeton University, Aeronautical Engineering Laboratory, Report No. 195*, April 20, 1952. 110 pp., illus. 29 references. (Based on a Ph.D. thesis.)

An Estimate of Viscosity Effect on the Hypersonic Flow Over an Insulated Wedge. Shan-fu Shen. *Journal of Mathematics and Physics*, Vol. 31, No. 3, October, 1952, pp. 192–205, illus. 4 references.

An Approximate Method for Determining the Displacement Effects and Viscous Drag of Laminar Boundary Layers in Two-Dimensional Hypersonic Flow. Mitchel H. Bertram. *U.S., N.A.C.A., Technical Note No. 2773*, September, 1952. 41 pp., illus. 19 references.

On Curved Shocks in Steady Plane Flow of an Ideal Fluid. C. Truesdell. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 826–828. 2 references.

Note on the Distribution of Singular Directions of a Two-Dimensional Shock. S. F. Shen. *Journal of Mathematics and Physics*, Vol. 31, No. 2, July, 1952, pp. 102–108, illus. 4 references.

Experiments on Transonic Flow Around Wedges. George P. Wood. *U.S., N.A.C.A., Technical Note No. 2829*, November, 1952. 34 pp., illus. 4 references.

On the Fine-Scale Structure of Turbulence. A. A. Townsend. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1095, September 24, 1951, pp. 534–542, illus. 7 references.

The Effect of Homogeneous Turbulence on Material Lines and Surfaces. G. K. Batchelor. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1114, July 8, 1952, pp. 349–366. 5 references.

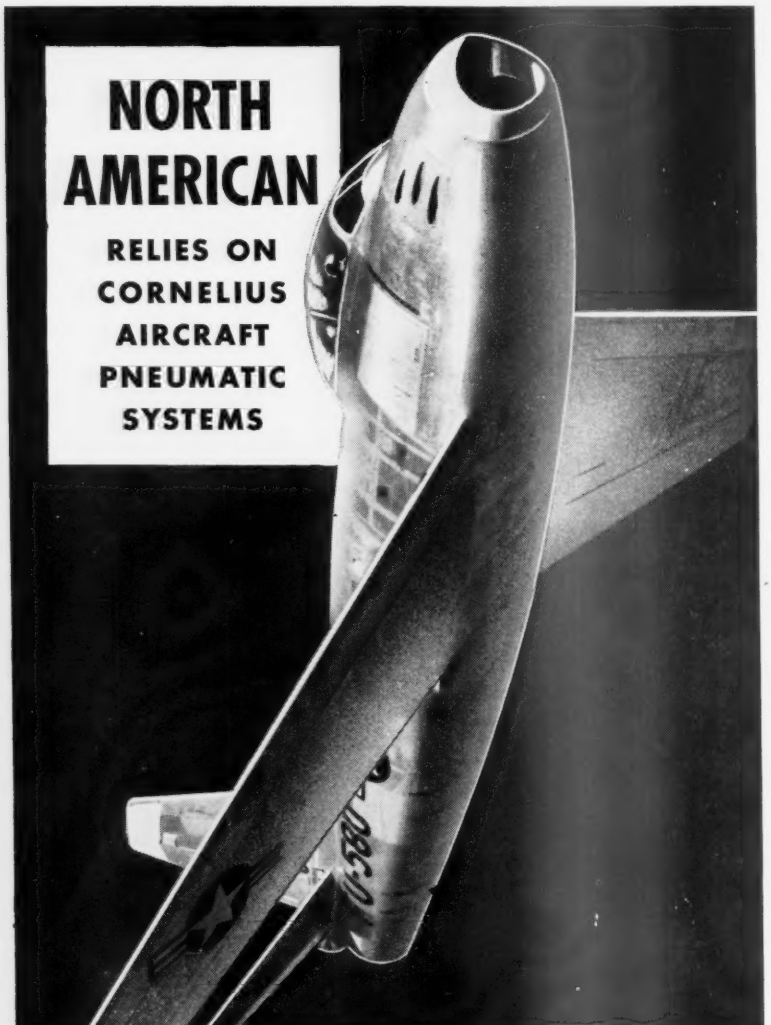
The Gravitational Instability of an Infinite Homogeneous Turbulent Medium. S. Chandrasekhar. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1100, December 7, 1951, pp. 26–29. 3 references.

The Fluctuations of Density in Isotropic Turbulence. S. Chandrasekhar. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1100, December 7, 1951, pp. 18–25. 3 references.

The Generation of Noise by Isotropic Turbulence. I. Proudman. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1116, August 7, 1952, pp. 119–132. 4 references.

Internal Flow

An Investigation of the Flexure-Torsion Flutter Characteristics of Aerofoils in Cas-



NORTH AMERICAN F-86E Sabre. *Outstanding Air Force Fighter.*

Since the early days of the B-25, NORTH AMERICAN has repeatedly specified Cornelius Pneumatic Equipment . . . and our compressors, pressure regulators, relief valves, check valves, etc., are being battle tested daily aboard Sabres in Korea.

During the past 11 years Cornelius has built more than 25,000 high pressure air compressors for the Air Force, Navy and leading aircraft manufacturers. You will profit from our experience . . . write to us about your pneumatic equipment requirements.

CORNELIUS PNEUMATIC EQUIPMENT

AIR COMPRESSORS • CHECK VALVES • PRESSURE REGULATORS • PRESSURE SWITCHES • RELIEF VALVES • AIR BRAKE VALVES • AIR BOTTLES

THE Cornelius COMPANY

550-39th Avenue Northeast • Minneapolis 21, Minnesota

Pioneers in the Development of Aircraft Pneumatic Systems

cade. G. M. Lilley. *College of Aeronautics, Cranfield, England, Report No. 60*, May, 1952. 71 pp., illus. 8 references.

Effect of Geometry on Secondary Flows in Blade Rows. A. G. Hansen, G. R. Costello, and H. Z. Herzig. *U.S., N.A.C.A., Research Memorandum No. E52H26*, October 16, 1952. 38 pp., illus. 1 reference.

Readers' Forum: Note on the Two-Dimensional Losses in Cascades. A. Charwat. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 851, 852, illus. 3 references.

Comparison of Two- and Three-Dimensional Potential-Flow Solutions in a Rotating Impeller Passage. Gaylord O. Ellis and John D. Stanitz. *U.S., N.A.C.A., Technical Note No. 2806*, October, 1952. 61 pp., illus. 8 references.

Effect of Changing Passage Configuration on Internal-Flow Characteristics of a 48-Inch Centrifugal Compressor. II—Change in Hub Shape. John Mizisin and Donald J. Michel. *U.S., N.A.C.A., Technical Note No. 2835*, November, 1952. 35 pp., illus. 6 references.

Flow Surfaces in Rotating Axial-Flow Passages. John D. Stanitz and Gaylord O. Ellis. *U.S., N.A.C.A., Technical Note No. 2834*, November, 1952. 31 pp., illus. 8 references.

Investigation of Flow Fluctuations at the Exit of a Radial-Flow Centrifugal Impeller. Joseph T. Hamrick and John Mizisin. *U.S., N.A.C.A., Research Memorandum No. E52H11*, October 13, 1952. 20 pp., illus. 6 references.

Several Combination Probes for Surveying Static and Total Pressure and Flow Direction. Wallace M. Schulze, George C. Ashby, Jr., and John R. Erwin. *U.S., N.A.C.A., Technical Note No. 2830*, November, 1952. 64 pp., illus. 6 references.

Some Data Pertaining to the Supersonic Axial-flow Compressor. I. M. Davidson. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2554*, 1951 (May, 1947). 38 pp., illus. 10 references. British Information Services, New York. $2.50.

An Extension of the Momentum Theory of Wind Turbines. H. H. Rosenbrock. *Aircraft Engineering*, Vol. 24, No. 282, August, 1952, pp. 226, 227, illus. 6 references.

Some Notes on Centrifugal Compressors. L. N. Thompson. *Aircraft Engineering*, Vol. 24, No. 282, August, 1952, pp. 231–233, illus. Derivation of the basic theory and some comparisons with axial machines.

The Flow of Gases Through Capillaries. J. A. W. Huggill. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 212, No. 1108, April 8, 1952, pp. 123–136, illus. 14 references. Experimental differential analysis; comparison with theoretical results.

Secondary Circulation in Fluid Flow. W. R. Hawthorne. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 206, No. 1086, May 7, 1951, pp. 374–387, illus. 6 references. Theoretical analysis in bent circular pipes; comparison with experiment.

Tables of Velocity of Steady Laminar Flow in Channels of Rectangular Cross Section. Robert W. Smith, Jr., Helen E. Edwards, and Stuart R. Brinkley, Jr. *U.S., Department of the Interior, Bureau of Mines, Report of Investigations No. 4885,* July, 1952. 41 pp., illus. 7 references.

The Flow in an Axially-Symmetric Supersonic Jet from a Nearly-Sonic Orifice into a Vacuum. P. L. Owen and C. K. Thornhill. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2616,* 1952 (September, 1948). 8 pp., illus. 3 references. British Information Services, New York. $0.65.

Disturbances Arising from the Instability of a Jet. E. W. Graham. *Douglas Aircraft Company, Inc., Report No. SM-14076,* July 6, 1951. 18 pp., illus. 4 references.

Performance

A Theoretical Investigation of the Response of a High-Speed Aeroplane to the Application of Ailerons and Rudders. K. Mitchell, A. W. Thorpe, and E. M. Frayn. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2294,* 1952 (May, 1945). 92 pp., illus. 8 references. British Information Services, New York. $5.75.

Manoeuvrability at High Speeds; The Effects of Mach Number and Height on the Stalling Speed and Other Characteristics Affecting Manoeuvrability. A. H. Yates. *Aircraft Engineering,* Vol. 24, No. 282, August, 1952, pp. 228–230, illus. 4 references.

An Analysis of Normal Accelerations and Airspeeds of One Type of Twin-Engine Transport Airplane in Commercial Operations Over a Northern Transcontinental Route. Roy Steiner. *U.S., N.A.C.A., Technical Note No. 2833,* November, 1952. 23 pp., illus. 11 references.

Flight Tests on the Performance of Meteor IV (A Twin-Engined, Single-Seat Jet Fighter). F. Smith, D. J. Higton, and R. H. Plascott. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2446,* 1951 (August, 1946). 11 pp., illus. 3 references. British Information Services, New York. $0.75.

High-speed Wind-tunnel Tests on Models of Four Single-engined Fighters (Spitfire, Spiteful, Attacker and Mustang) Parts 1–5. W. A. Mair (Editor). *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2535,* 1951 (April, 1945). 79 pp., illus. 2 references. British Information Services, New York. $4.50.

The Effect of the Sweepback of Delta Wings on the Performance of an Aircraft at Supersonic Speeds. A. Robinson and F. T. Davies. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2476,* 1951 (March, 1947). 6 pp., illus. 3 references. British Information Services, New York. $0.55.

Charts for Evaluating Rolling Performance. Bernard Etkin. *Canada, National Aeronautical Establishment, Report No. R.13,* 1951. 13 pp., illus.

Stability & Control

An Analysis of the Errors in Curve-Fitting Problems with an Application to the Calculation of Stability Parameters from Flight Data. Marvin Shinbrot. *U.S., N.A.C.A., Technical Note No. 2820,* November, 1952. 29 pp., illus. 3 references.

Ground Effect on Downwash with Slipstream. P. R. Owen and H. Hogg. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda, No. 2449,* 1952 (January, 1944). 12 pp., illus. 5 references. British Information Services, New York. $0.90.

Tests on a Control with Fixed Trailing-edge Angle, and Surfaces of Variable Camber. A. S. Halliday, H. Deacon, and W. C. Skelton. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2495,* 1952 (May 12, 1947). 15 pp., illus. 1 reference. British Information Services, New York. $1.00.

Readers' Forum: Prediction of Yawing Stability Characteristics of Airplanes During Catapulting—Errata and Additional Remarks. Henry J. Kelley. *Journal of the Aeronautical Sciences,* Vol. 19, No. 12, December, 1952, p. 848. 1 reference.

Automatic Control Systems Satisfying Certain General Criterions on Transient Behavior. Aaron S. Boksenbom and Richard Hood. (*U.S., N.A.C.A., Technical Note No. 2378,* 1951.) *U.S., N.A.C.A., Report No. 1068,* 1952. 13 pp., illus. 6 references. Superintendent of Documents, Washington. $0.15.

A Theoretical Investigation into the Lateral Stability of an Aeroplane Controlled by an Automatic Pilot, with Particular Reference to the Effect of Flight Path Angle. T. W. Prescott. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2640,* 1952 (January, 1948). 11 pp., illus. 2 references. British Information Services, New York. $0.75.

Effect of High-Lift Devices on the Static-Lateral-Stability Derivatives of a 45° Sweptback Wing of Aspect Ratio 4.0 and Taper Ratio 0.6 in Combination with a Body. Jacob H. Lichtenstein and James L. Williams. *U.S., N.A.C.A., Technical Note No. 2819,* November, 1952. 50 pp., illus. 8 references.

The Effects on Dynamic Lateral Stability and Control of Large Artificial Variations in the Rotary Stability Derivatives. Robert O. Schade and James L. Hassell, Jr. *U.S., N.A.C.A., Technical Note No. 2781,* October, 1952. 56 pp., illus. 12 references.

Lateral Reponse Theory. Appendices. E. M. Frayn. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2297,* 1952 (March, 1944). 57 pp. 17 references. British Information Services, New York. $3.40.

An Examination of the Technique of the Measurement of the Longitudinal Manoeuvring Characteristics of an Aeroplane, and a Proposal for a Standardised Method. D. J. Lyons. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda, No. 2597,* 1952 (September, 1947). 33 pp., illus. 8 references. British Information Services, New York. $1.40.

Wings & Airfoils

Approximate Two-dimensional Aerofoil Theory. I—Velocity Distributions for Symmetrical Aerofoils. II—Velocity Distributions for Cambered Aerofoils. III—Approximate Designs of Symmetrical Aerofoils for Specified Pressure Distributions. IV—The Design of Centre Lines. V—The Positions of Maximum Velocity and Theoretical C_L Ranges. S. Goldstein and E. J. Richards (Pt. III). *Gt. Brit., Aeronautical Research Council, Current Papers Nos. 68–72,* 1952. 59, 62, 40, 49, 26 pp., illus. 43 references. British Information Services, New York. $2.50, $2.50, $1.90, $2.45, $1.25.

Investigation into the Application of the Method of Theodorsen & Garrick for the Calculation of the Pressure Distribution of an Airfoil. J. Cohen. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Report No. F. 14,* August 26, 1947. 18 pp., illus., folded charts and tables. 2 references.

Theory of the Calculation of Load-Distribution for Yawed and Swept Wings in Incompressible Flow. A. van Heemert. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Report No. F. 91,* August 4, 1951. 35 pp., illus. 12 references.

The Potential Due to a Source Moving Through a Compressible Fluid and Applications to Some Rotary Derivatives of an Aerofoil. R. Westley. *College of Aeronautics, Cranfield, England, Report No. 54,* February, 1952. 32 pp., illus. 5 references.

Readers' Forum: On the Noncirculatory Flow About a Two-Dimensional Airfoil at Subsonic Speeds. Bernard Mazelsky. *Journal of the Aeronautical Sciences,* Vol. 19, No. 12, December, 1952, pp. 848, 849, illus. 3 references.

Calculated Aerodynamic Characteristics of Two Infinite Wings with Constant Chord. V. M. Falkner. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2594,* 1952 (May, 1947). 10 pp., illus. 2 references. British Information Services, New York. $0.75.

Integrals and Integral Equations in Linearized Wing Theory. Harvard Lomax, Max A. Heaslet, and Franklyn B. Fuller. (*U.S., N.A.C.A., Technical Note No. 2252,* 1950.) *U.S., N.A.C.A., Report No. 1054,* 1951. 34 pp., illus. 18 references. Superintendent of Documents, Washington. $0.30.

Langley Full-Scale-Tunnel Investigation of the Maximum-Lift and Stalling Characteristics of a Trapezoidal Wing of Aspect Ratio 4 with Circular-Arc Airfoil Sections. Roy H. Lange. (*U.S., N.A.C.A., Research Memorandum No. L7H19,* 1947.) *U.S., N.A.C.A., Technical Note No. 2823,* November, 1952. 24 pp., illus. 5 references.

Tests on a Glas II Wing without Suction in the Compressed Air Wind Tunnel. C. Salter, J. W. Miles, and R. Owen. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2540,* 1951 (February 16, 1948). 21 pp., illus. 3 references. British Information Services, New York. $1.25.

Tests on a "Glauert" Nose-suction Aerofoil in the N.P.L. 4-ft. No. 2 Wind Tunnel. F. Cheers and Ola Douglas.

Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2356, 1952 (April 15, 1947.) 5 pp., illus. 3 references. British Information Services, New York. $0.55.

Wind-Tunnel Tests on a Thick Suction Aerofoil with a Single Slot. M. B. Glauert, W. S. Walker, W. G. Raymer, and N. Gregory. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2646*, 1952 (October, 1948). 14 pp., illus. 11 references. British Information Services, New York. $1.00.

N.P.L. Aerofoil Sections: Tabulated Details. *Gt. Brit., National Physical Laboratory, Aerodynamics Division, No. 211*, July, 1951. 27 pp. 16 references. Aerodynamic data of theoretical values on N.P.L. designed, modified, or studied airfoils.

Pressure Distributions at High Speed on EC 1250 (Data Report). J. A. Beavan and G. A. M. Hyde. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2625*, 1952 (July, 1947). 12 pp., illus. 7 references. British Information Services, New York. $0.90.

Pressure Plotting Tests in the Royal Aircraft Establishment High Speed Wind Tunnel on a 21 per cent Thick, Low Drag Aerofoil (Brabazon I Wing Root Section). A. B. Haines. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2617*, 1952 (October, 1947). 24 pp., illus. 7 references. British Information Services, New York. $1.50.

Theoretical Determination of the Minimum Drag of Airfoils at Supersonic Speeds. Robert T. Jones. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 813–822, illus. 11 references.

Effects of Independent Variations of Mach Number and Reynolds Number on the Maximum Lift Coefficients of Four NACA 6-Series Airfoil Sections. Stanley F. Racisz. *U.S., N.A.C.A., Technical Note No. 2824*, November, 1952. 32 pp., illus. 13 references.

A Comparative Examination of Some Measurements of Airfoil Section Lift and Drag at Supercritical Speeds. Gerald E. Nitzberg and Stewart M. Crandall. *U.S., N.A.C.A., Technical Note No. 2825*, November, 1952. 30 pp., illus. 13 references.

A Drag Reduction Method for Wings of Fixed Plan Form. E. W. Graham. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 823–825, illus. 6 references.

Tables of Multhopp and other Functions for Use in Lifting-Line and Lifting-Plane Theory. V. M. Falkner and E. J. Watson. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2593*, 1952 (February, 1948). 52 pp., illus. 3 references. British Information Services, New York. $3.15.

Airfoil Profiles for Minimum Pressure Drag at Supersonic Velocities—General Analysis with Application to Linearized Supersonic Flow. Dean R. Chapman. (*U.S., N.A.C.A., Technical Note No. 2264*, 1951.) *U.S., N.A.C.A., Report No. 1063*, 1952. 14 pp., illus. 9 references. Superintendent of Documents, Washington. $0.20.

An Investigation of Boundary Layer Effects on Two Dimensional Supersonic Aerofoils. H. K. Zienkiwicz. *College of Aeronautics, Cranfield, England, Report No. 49*, December, 1951. 110 pp., illus. 42 references. 5*s*.

An Example in Wing Theory at Supersonic Speed. H. B. Squire. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2549*, 1951 (February, 1947). 12 pp., illus. 4 references. British Information Services, New York. $1.15.

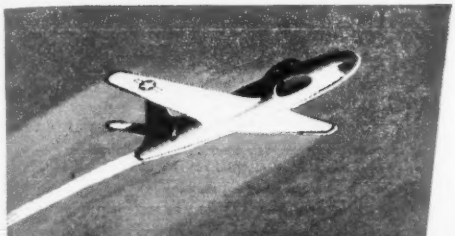
Limitations of Use of Busemann's Second-order Supersonic Aerofoil Theory. W. F. Hilton. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2524*, 1952 (August 8, 1946). 9 pp., illus. 3 references. British Information Services, New York. $0.65.

A Solution of the Telegraph Equation with Application to Two-Dimensional Supersonic Shear Flow. Chieh-Chien Chang and Jack Werner. *Journal of Mathematics and Physics*, Vol. 31, No. 2, July, 1952, pp. 91–101, illus. 6 references.

Effect of a Finite Trailing-Edge Thickness on the Drag of Rectangular and Delta Wings at Supersonic Speeds. E. B. Klunker and Conrad Rennemann, Jr. *U.S., N.A.C.A., Technical Note No. 2828*, November, 1952. 26 pp., illus. 3 references.

Formulas for the Supersonic Loading, Lift and Drag of Flat Swept-Back Wings with Leading Edges Behind the Mach Lines. Doris Cohen. *U.S., N.A.C.A., Report No. 1050*, 1951. 40 pp., illus. 19 references.

the
SHADOW
behind..
tomorrow's aircraft
In the future as well as today, America's aircraft will excel in design, construction...and components. As suppliers to the nation's major airframe manufacturers, Universal keeps pace with today's volume needs, while designing and planning components which will be required for tomorrows' supersonic aircraft.
Being specialists in tool and component design, metal stamping, heliarc and resistance welding and sub-assemblies, Universal invites correspondence concerning your company's requirements.
UNIVERSAL METAL PRODUCTS, INC.
Tools • Dies • Metal Stampings • Aircraft Parts
Serving America's Aircraft Industry
2311 West Orange Street
CUmberland 3-3115
Alhambra, California



the colder it gets

the more you need

HYCO-SPAN

the new aircraft control cable

● When you are 'way upstairs, where it gets colder than cold, you can still have constant pin-point control of any ship that is equipped with U·S·S American HYCO-SPAN Control Cable.

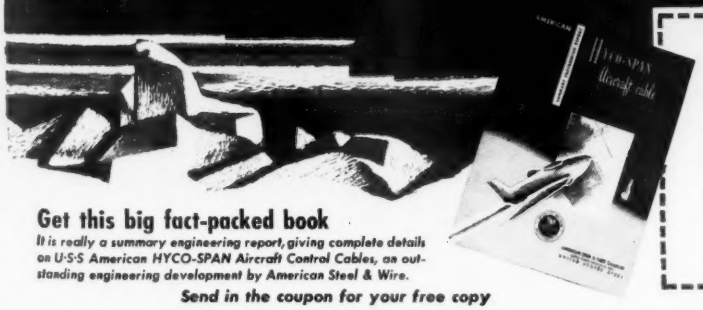
It took many years of painstaking research and experiment to develop the special steel which enables HYCO-SPAN to expand and contract at practically the same rate as the plane's aluminum frame. Even without temperature compensating devices, HYCO-SPAN helps to prevent controls from loosening or tightening up, becoming "sloppy" or "mushy" and keeps planes from developing "flutters, shivers and shakes."

Note the five main advantages you get with HYCO-SPAN Control Cable—listed here—and then send for complete information as set forth in our recent book. We shall be glad to mail you a copy.

Only HYCO-SPAN Control Cable gives you all these advantages

1. Expands and contracts at a rate similar to 24 S-T aluminum alloy.
2. Is non-magnetic, does not affect sensitive aircraft control instruments.
3. Eliminates the need for most temperature compensating devices.
4. Has corrosion resistance of stainless steel, hence lasts longer where corrosion is severe.
5. Reduces cable friction, and has better stability, which may permit reduction of cable tension, resulting in longer lasting service.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION
GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK



Get this big fact-packed book

It is really a summary engineering report, giving complete details on U·S·S American HYCO-SPAN Aircraft Control Cables, an outstanding engineering development by American Steel & Wire.

Send in the coupon for your free copy

American Steel & Wire
Room 844, Rockefeller Bldg., Cleveland 13, Ohio

Please send me your booklet on Hyco-Span Aircraft Cable.

Name.....
Company.....
Position.....
Address.....
City.....State.....

DEPARTMENT OF TECHNOLOGY
BUFFALO PUBLIC LIBRARY

U·S·S American HYCO-SPAN Aircraft Cables

UNITED STATES STEEL

Interference on a Wing Due to a Body at Supersonic Speeds. S. Kirkby and A. Robinson. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2500*, 1952 (April, 1947). 10 pp., illus. 3 references. British Information Services, New York. $0.75.

Calculation of the Influence of a Body on the Position of the Aerodynamic Centre of Aircraft with Swept-back Wings. H. Schlichting. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2582*, 1952 (March, 1947). 13 pp., illus. 12 references. British Information Services, New York. $0.90.

Aeroelasticity

Dynamic Aeroelasticity of Aircraft with Swept Wings. J. R. M. Radok. *College of Aeronautics, Cranfield, England, Report No. 58*, April, 1952. 44 pp., illus. 20 references.

On the Application of Statistical Concepts to the Buffeting Problem. H. W. Liepmann. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 793–800, 822, illus. 14 references.

An Investigation of the Flexure-Torsion Flutter Characteristics of Aerofoils in Cascade. G. M. Lilley. *College of Aeronautics, Cranfield, England, Report No. 60*, May, 1952. 71 pp., illus. 8 references.

Experimental Flutter Analysis. E. Berkeley Kinnaman. *Aero Digest*, Vol. 65, No. 2, August, 1952, pp. 64–66, 68, 70, 72, 74, 76–78, illus. Boeing Airplane Company investigations.

Spontaneous Oscillations of an Aerofoil Due to Instability of the Laminar Boundary Layer. A. I. van de Vooren and H. Bergh. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Report No. F. 96*, 1951. 5 pp., illus. 7 references.

Supplementary Tables for Special Functions Used in the Calculation of Airloads on Oscillating Wings (Special Functions of NACA TN 1195). R. J. Crookshanks. *Douglas Aircraft Company, Inc., Report No. SM-14200*, November 27, 1951. 18 pp. 4 references.

Downwash Behind a Two-Dimensional Wing Oscillating in Plunging Motion. E. Lapin, R. J. Crookshanks, and H. F. Hunter. *Douglas Aircraft Company, Inc., Report No. SM-14198*, November 21, 1951. 11 pp., illus. 4 references.

Free Vibration of a Rotating Elastic Body; The General Theory and Some Examples of Practical Cases. D. C. Johnson. *Aircraft Engineering*, Vol. 24, No. 282, August, 1952, pp. 234–236, illus. 4 references.

Aircraft Vibration Research. D. M. Corke. *Electronic Engineering, Electronics in Industry Supplement*, Vol. 24, No. 297, 1952, pp. 518–522, illus.

Aeronautics, General

The British Association. *The Engineer*, Vol. 194, No. 5042, September 12, 1952, pp. 357–359. 1952 Belfast Meeting discussions on some major aeronautical problems.

Progress in Aeronautical Science and Engineering. Ben Lockspeiser. *The Engineer*, Vol. 194, No. 5042, September 12, 1952, pp. 349–351, illus. (Based on paper presented at the Belfast Meeting, British Association, September 5, 1952.)

Waterbased Jet Airliners Advocated to Pass Foreign Competition; New Engineering Problems in the Spotlight at . . . SAE (National) Aeronautic Meeting in Los Angeles. R. Raymond Kay. *Automotive Industries*, Vol. 107, No. 9, November 1, 1952, pp. 48, 49, 114, 116, 118, 120, illus. Discussion of problems involving materials, production, and operation of supersonic aircraft, at the S.A.E. Meeting, October, 1952.

Air Transportation

Air Transportability with MATS (Military Air Transport Service). Joseph Smith. *American Society of Mechanical Engineers, Annual Meeting, New York, November 30–December 5, 1952, Paper No. 52-A-154.* 11 pp., illus. Developments in traffic and cargo operations; jet air transportation factors; the Air Force's use of the Lockheed turboprop C-130.

Damon Looks at the Jet; Jet Transports by 1960. James H. Winchester. *Aviation Age*, Vol. 17, No. 2, August, 1952, pp. 38, 39, illus. An evaluation by T.W.A.'s President.

The Impact of Turbines on Airlines. Edward A. Driessen. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 767.* 37 pp., illus. 22 references.

Maintaining Airworthiness in Operation. R. E. Hardingham. *Royal Aeronautical Society, Journal*, Vol. 56, No. 503, November, 1952, pp. 819–840, illus. (The Eighth British Commonwealth and Empire Lecture.) Covers civil transport operations.

Results of Loadair Operation in South America. H. W. Anderson. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 823B.* 16 pp., illus. Details of installation at Avianca's Soledad Airport, Baranquilla, Colombia.

Behind Tomorrow's Growth: Air Freight. William D. Perreault. *American Aviation*, Vol. 16, No. 13, November 24, 1952, pp. 17, 18, illus. Economic trends; prospects to 1958.

Business Analysis of the Aviation Industry in Illinois. Richards C. Osborn. *Illinois, University, Bureau of Economic and Business Research, Bulletin No. 75*, 1952 (*Illinois, University, Bulletin, Vol. 50, No. 9*, September, 1952). 68 pp. 8 references.

Economics of New Aircraft Selection. Armin Baltensweiler. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 765.* 25 pp., illus. Practical criteria for air lines.

Operating Costs of a Light Aircraft Fleet. Leslie A. Bryan. *Illinois, University, Institute of Aviation, Aeronautics Bulletin, No. 10*, 1952 (*Illinois, University, Bulletin, Vol. 50, No. 14*, September, 1952). 13 pp., illus.

Who's Uneconomic? Not Jets, Say Builders. Anthony Vandyk. *American Aviation*, Vol. 16, No. 13, November 24, 1952, pp. 22, 23, illus. European turbo-air-line development; adaptations of de Havilland Comets, Dart DC-3's, Viscount 700 and 800 series, HD45, and other aircraft.

Germany and the Pattern of European Air Transport. *Aeronautics*, Vol. 27, No. 3, October, 1952, pp. 75, 76, illus.

Hong Kong Aviation Trio Serves Orient. George L. Christian. *Aviation Week*, Vol. 57, No. 17, October 27, 1952, pp. 64, 67, 69, 70, 74, illus. Activities of Hong Kong Aircraft Engineering Co., Ltd., Cathay Pacific Airways, and Hong Kong Airways.

Japanese Carriers Bid for Pacific Routes. F. Lee Moore. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, pp. 84, 86. Japan International World Airways and Japan Air Lines plans.

The Operation of the English Channel Air Ferry. G. J. Powell. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 766.* 11 pp., illus.

Passengers Come First. Henry M. Henion. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 823A.* 6 pp., illus. Passenger-traffic needs.

HAL Plays Dual Role in Hawaii. George L. Christian. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, pp. 69, 70, 73, 74, 76, 77, illus. Hawaiian Air Lines' cargo and passenger transport activities.

Hawaiian Melody. David West. *Aeronautics*, Vol. 27, No. 3, October, 1952, pp. 66–72, illus. Activities of the Hawaiian Air Lines.

PAL's Progress. David West. *Aeronautics*, Vol. 27, No. 2, September, 1952, pp. 160–162, 165–168, illus. Activities of the Philippine Air Lines, Inc.

Trans-Canada Airlines' Progress, 1946–1950—A Comparison with U.S. Trunk Lines. Adam Jaworski. *Journal of Air Law and Commerce*, Vol. 19, No. 3, Summer, 1952, pp. 305–316, illus. 12 references.

Airplane Design

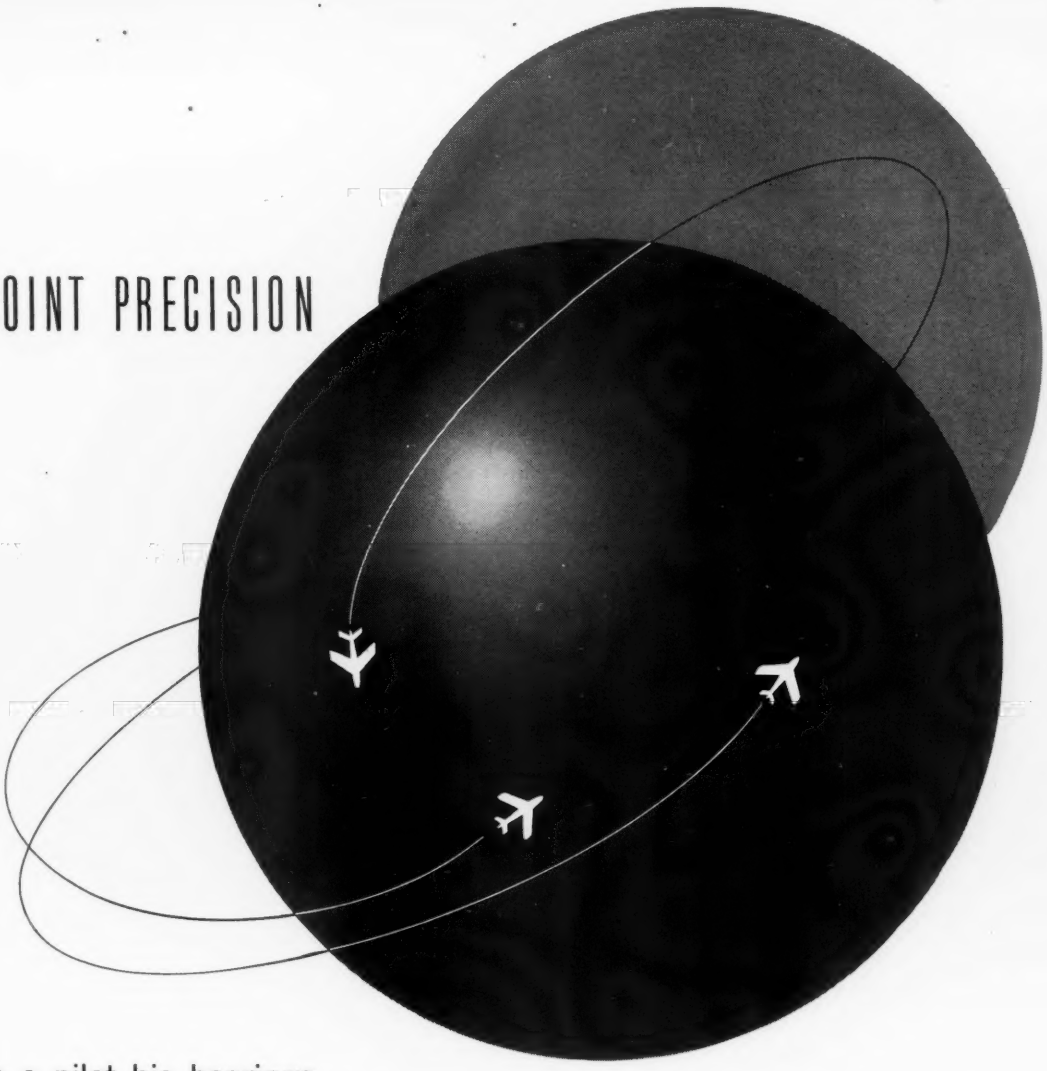
Committee S-7 Cockpit Report. M. Le Roy Stoner and M. C. Beard. *Skyways*, Vol. 11, No. 12, December, 1952, pp. 21, 58, illus.

Cockpit Simplification and Standardization. *Skyways*, Vol. 11, No. 12, December, 1952, pp. 23–25, 38–47. (Flight Operations Round Table No. 3.)

Model Tests in the 24-ft. Wind Tunnel to Determine the Optimum Angle for Release of a Cockpit Hood. R. Fail. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2644*, 1952 (March, 1948). 3 pp., illus. 2 references. British Information Services, New York. $0.35.

Designing to Avoid Dangerous Behaviour of an Aircraft due to the Effects on Control Hinge Moments of Ice on the Leading Edge of the Fixed Surface. D. E. Morris. *Gt. Brit., Aeronautical Research Council, Current Papers No. 66*, 1952 (March, 1947). 10 pp., illus. 5 references. British Information Services, New York. $0.55.

PIN POINT PRECISION



gives a pilot his bearings

Aircraft circling the globe must reach distant destinations with pin point precision. Even a hairline variation from absolute accuracy in instrument readings could mean grave errors in flight calculations.

Because of their ability to operate with minimum torque, New Departure ball bearings are widely used in sensitive instrumentation. To assure the highest standards of precision and accuracy, New Departure maintains special manufacturing facilities.

If you have an application that demands accurate, low friction support of moving parts, under low torque or high speed operating conditions, New Departure can best meet the requirements. In the air, keep your eye on the BALL to be sure of your BEARINGS!

Laboratories of scientific tools and processes, New Departure's instrument bearing areas are sealed, air conditioned and slightly pressurized to keep out dust. Under these ideal conditions, bearings are assembled, tested and packed.

New Departure ball bearings are quickly available from the industry's largest nation-wide network of warehouse stocks.

NOTHING ROLLS LIKE A BALL

NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
Also makers of the famous New Departure Coaster Brake

American Helicopter Co. XH-26 "Jet-Jeep"

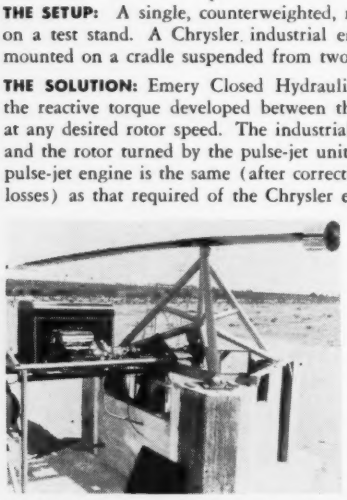
EMERY SOLVED THIS WEIGHING PROBLEM

FOR THE AMERICAN HELICOPTER CO., Mesa, Ariz.

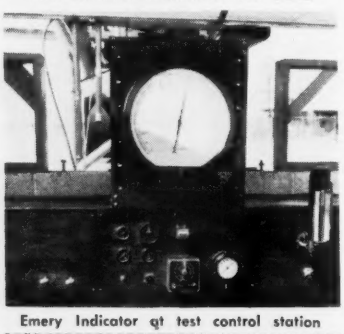
THE PROBLEM: Determine the thrust of rotor tip-mounted pulse-jet engines under simulated flight conditions.

THE SETUP: A single, counterweighted, main rotor blade with pulse-jet unit is mounted on a test stand. A Chrysler industrial engine, geared to rotate the blade under test, is mounted on a cradle suspended from two points on the centerline of its own drive shaft.

THE SOLUTION: Emery Closed Hydraulic Weighing System. An EC-30 Cell "weighs" the reactive torque developed between the Chrysler motor cradle and its support frame at any desired rotor speed. The industrial engine is then uncoupled from the rotor shaft, and the rotor turned by the pulse-jet unit at the same speed. The torque provided by the pulse-jet engine is the same (after correction for mechanical power transmission and other losses) as that required of the Chrysler engine to run the rotor at the given rate.



Pulse-Jet Rotor mounted on Test Stand



Emery Indicator at test control station

A 16 INCH, 0-1000 POUND Emery Bourdon Indicator is mounted with other instruments and controls at the operator's station beneath the test stand. The Emery indicator is calibrated in two-pound increments.

ACCURACY WAS PROVEN by American Helicopter Co. engineers, who found the Emery system provided thrust data whose error was less than 1%.

LET EMERY SOLVE YOUR WEIGHING PROBLEM

AT LOW COST for purchase and operation.

WIDE RANGE of stock sizes of Emery Closed Hydraulic, Hydraulic Flow, and Pneumatic Cells permit precision measurement of 1 to 100,000 pounds. Also special sizes up to 10,000,000 pounds.

WRITE TODAY FOR ALL THE FACTS on how Emery can solve YOUR Force Measuring Problem in Precision Weighing . . . Brake Testing . . . Torque or Torsion Measurements . . . Cable, Chain or Rope Testing . . . Strength of Materials or Structures . . . Jet Engine Thrust . . . Towing or Traction Tests . . . or some unusual application of your own. Emery Engineers welcome your most difficult weighing problem.

THE A. H. EMERY CO. **NEW CANAAN 1, CONNECTICUT**

Please send literature on Hydraulic Weighing ( ) Pneumatic Weighing ( ) TEL. NEW CANAAN 9-9595

Our problem is:_____

Max. load_____ % Accuracy required_____

Max. permitted response time lag_____

NAME_____

POSITION_____

(Please attach to your business letterhead)

THE A. H. EMERY CO. PRECISION SINCE 1872 FORCE MEASUREMENT

DEPARTMENT OF TECHNICAL PUBLICATIONS BUREAU OF PUBLIC LIBRARIES

Britannia Pre-Flight Testing. *Flight*, Vol. 62, No. 2272, August 8, 1952, pp. 149, 150, illus. Mock-up and test frames.

Automatic Landing Wheel Braking. *The Engineer*, Vol. 194, No. 5045, October 3, 1952. pp. 460–462, illus. The Maparat and Decelostat systems.

Drop Testing a Large Airplane. J. W. Gaines and F. V. Wagner. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 815.* 24 pp., illus.

Air Conditioning & Pressurization

Air Conditioning Systems. E. S. McCarthy. *SAE Journal*, Vol. 60, No. 8, August, 1952, pp. 34, 35. (Based on a paper presented at S.A.E., National Aeronautic Meeting, New York, April 21, 1952.) Application of air-line operators' experience to design development.

Atmospheric Wet Bulb Temperature. J. A. C. Williams. *Aircraft Engineering*, Vol. 24, No. 282, August, 1952, pp. 221, 222, illus. 2 references. Definitions and assumptions about moist air; applications.

Effect of Temperature on Azeotropy in 1,1-Difluoroethane and Dichlorodifluoromethane. W. A. Pennington. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2397–2401, illus. 8 references. Carrene-7, new refrigerant; other systems.

Give Them Air. *Aeronautics*, Vol. 27, No. 2, September, 1952, p. 172, illus. The Godfrey air conditioning trolley for ground servicing.

High Altitude B-36 Cabin Pressurization Operating Experiences. W. C. Dietz. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 757.* 8 pp., illus.

Improved Passenger Comfort Through the Application of Airline Experience to Air Conditioning System Design. E. S. McCarthy. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 758.* 7 pp., illus. 3 references.

Pressurizing A (Beech T-36A) Trainer (Aviation Design Progress). Randolph Hawthorne. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 38, 39, illus.

Smoother Flying for Air Force Trainees. V. L. Whitney, Jr. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 36, 37, illus. The Stratos EA 50-3 system for the Beech T-36A trainer transport.

Descriptions

Battling Bantams; Light Aircraft for Hit-and-run Attack. . . . *Flight*, Vol. 62, No. 2272, August 8, 1952, pp. 147, 148, illus. The Fletcher FD-25, Temco T-35, North American T-6, and other aircraft.

Fairchild C-119H Skyvan. *Aero Digest*, Vol. 65, No. 2, August, 1952, pp. 24–32, 34, 35, 38, 40, 42, 44, 45, 47, illus.: cutaway drawing. Survey of Fairchild cargo planes from the 1929 XC-8 model to the C-119H; specifications.

Farnborough Sets the Pace. Denis Desoutter. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 33–35, illus. Features of new delta wing and other aircraft at S.B.A.C. show.

Keeping the Flag flying. *Aeronautics*, Vol. 27, No. 3, October, 1952, pp. 24–31, illus. A review of aircraft at the S.B.A.C. show.

Three-Way Guide to British Aircraft. *Aeronautics*, Vol. 27, No. 2, September, 1952, pp. 52–72, illus. Specifications of 39 leading aircraft at S.B.A.C. show.

Introduction of New Transport Aircraft. R. C. Morgan. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 763.* 34 pp., illus. 8 references.

Jet Transports; A British-eye View. Vincent Evans. *Pegasus*, Vol. 19, No. 5, November, 1952, pp. 11–15, illus. The de Havilland Comets and the Bristol Britannia.

McDonnell Banshee. *Aero Digest*, Vol. 65, No. 3, September, 1952, pp. 22–32, 34, 36, 38, illus.; cutaway drawing. 1928–1953 McDonnell models; table of specifications.

Specifications for Ideal Corporate Air Transport. *Skyways*, Vol. 12, No. 1, January, 1953, pp. 23–25, 38–40, 42–46, illus. (Flight Operations Round Table No. 4.)

Tito Builds Air Power with Aid from West. . . . William Green. *Canadian Aviation*, Vol. 25, No. 8, August, 1952, pp. 42, 44, 58, 60, illus. Milutinovic Type 215, Stankov Type 214, S-49C Fighter, C-3 Trojka, and other types used in the Yugoslav Air Force.

The Turboprop Airplane. William W. Fox. *Skyways*, Vol. 11, No. 10, October, 1952, pp. 18–20, 60, illus. (Paper presented at the 20th Annual Meeting, Institute of the Aeronautical Sciences, New York, 1952.)

Auster Cirrus Autocar Four-Seater Personal Aircraft, England. *Aircraft News*, Vol. 4, No. 4, 1952, pp. 13–15, 18, illus.

Convair B-36D Ten-Engined (Piston-Jet) Bomber Aircraft. I, II. H. W. Hinckley. *Aviation Age*, Vol. 18, Nos. 2, 3, August, September, 1952, pp. 33–35; 34, 35, illus. Engineering and developmental aspects.

Convair B-36D Ten-Engined (Piston-Jet) Bomber Aircraft (Aviation Design Progress). Randolph Hawthorne. *Aviation Age*, Vol. 18, No. 2, August, 1952, pp. 36, 37, illus.; cutaway drawing. Design and structural details.

Convair-Liner 240 Twin-Engined Transport Aircraft. *Flight*, Vol. 62, No. 2272, August 8, 1952, pp. 157–159, illus.

Convair Turboliner Twin-Engined Turboprop Transport Aircraft. D. J. Nolan. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 756.* 14 pp., illus. Experience data.

de Havilland D. H. 104 Dove Twin-Engined 8–11-Place Transport Aircraft, England. *De Havilland Gazette, No. 71*, October, 1952, pp. 151–153, illus.

de Havilland D.H. 104 Dove Twin-Engined 8–11-Place Transport Aircraft, England. *Skyways*, Vol. 11, No. 12, December, 1952, pp. 10–13, 48, illus.

de Havilland D.H. 106 (Series 3) Comet Four-Engined Turbojet Transport Aircraft, England. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, pp. 12, 13.

Douglas C-124 Globemaster II Four-Engined Cargo Transport Aircraft. *Ryan Reporter*, Vol. 13, No. 5, August 1, 1952, pp. 10, 11, 21, 23, 24, illus.

Fiat G80 Turboprop Trainer-Fighter Aircraft, Italy (Aviation Design Progress). Randolph Hawthorne. *Aviation Age*, Vol. 18, No. 3, September, 1952, pp. 30, 31, illus.

Gloster G.A. 5 Javelin Twin-Engined Delta Wing Turbojet Fighter Aircraft, England. *Aviation Week*, Vol. 57, No. 16, October 20, 1952, pp. 21, 22, 24, 29, 30, illus.

Leduc-021 Ram-jet Interceptor Fighter Aircraft, France. *Aircraft*, Vol. 30, No. 11, August, 1952, pp. 20, 21, 42, illus.

Lockheed F-94C Starfire Turbojet All-Weather Fighter Aircraft. *Canadian Aviation*, Vol. 25, No. 8, August, 1952, p. 19, illus.

Lockheed 1049 Series Super Constellation Four-Engined Transport Aircraft. George L. Christian. *Aviation Week*, Vol. 57, No. 15, October 13, 1952, pp. 67, 69, 70, 72, 74, illus.

Martin 4-0-4 Twin-Engined 40-Passenger Transport Aircraft. Herbert O. Fisher. *Skyways*, Vol. 11, No. 10, October, 1952, pp. 14–17, 50, 51, illus.

MiG-15 Turbojet Fighter Aircraft, U.S.S.R. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 194, 195, illus. Data, obtained from captured models; comparison with F-94-C Starfire.

Miles Sparrowjet Twin-Engined Turbojet Light Aircraft, England. *Aeronautics*, Vol. 27, No. 3, October, 1952, p. 39, illus.

Model 150 Twin-Engined Turbojet Swept-Wing Bomber Aircraft, U.S.S.R. *Aviation Age*, Vol. 18, No. 5, November, 1952, p. 41, illus., cutaway drawing.

Model 150 Twin-Engined Turbojet Swept-Wing Bomber Aircraft, U.S.S.R. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 33–35, illus.

S.N.C.A.N. Nord 2501 Twin-Engined Cargo Aircraft, France. *Aeronautics*, Vol. 27, No. 3, October, 1952, p. 56, illus.

Saab 210 Draken Turbojet Delta-Wing Experimental Research Aircraft, Sweden. *Aviation Age*, Vol. 18, No. 4, October, 1952, p. 41, illus. Results of flight tests.

Vickers-Armstrongs 700 Viscount Four-Engined Turboprop Transport Aircraft, England. *Transport*, Vol. 2, No. 5, May, 1952, pp. 21, 22, 28, illus.

Vickers-Armstrongs 700 Viscount Four-Engined Turboprop Transport Aircraft, England. *Aviation Age*, Vol. 17, No. 2, August, 1952, pp. 13–16, illus.

Youngman-Baynes Two-Seater Monoplane High-Lift Experimental Aircraft, England. D. Lean. *Gt. Brit., Aeronautical Research Council, Current Papers No. 65*, 1952 (August, 1950). 54 pp., illus. 15 references. British Information Services, New York. $2.45.

Fuel Tanks

Airliners May Adopt Wing Tip Fuel Tanks. *Canadian Aviation*, Vol. 25, No. 8, August, 1952, pp. 32, 34, 35, 56, illus. Design and cost factors; implications.

The Characteristics of Fuel Motion Which Affect Airplane Dynamics. E. W. Graham and A. M. Rodriquez. *Douglas Aircraft Company, Inc., Report No. SM-14212*, November 27, 1951. 52 pp., illus. 6 references. Design aspects.

Effect of Aerodynamic Heating on Fuel Systems. Julius Jonas. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 812.* 14 pp., illus. 5 references.

Fuel On The Wing. *Ryan Reporter*, Vol. 13, No. 5, August 1, 1952, pp. 1, 18, 19, illus. Air Force's Fairchild C-119H fuel-system conversion.

Wing-Tip Fuel Tanks for Planes. *Transport*, Vol. 2, No. 5, May, 1952, p. 27, illus.

Wing Group

Derivation and Application of a General Formula for Directly Computing the Skin Thickness of Wings and Tailplanes. A. H. Hall. (*Canada, National Research Council, Division of Mechanical Engineering, Report No. MM-221*, April, 1950.) *Canada, National Aeronautical Establishment, Report No. R 12*, 1951. 24 pp., illus. 4 references.

On the Design of Airfoils in Which the Transition of the Boundary Layer Is Delayed. Itiro Tani. (*Tokyo Imperial University, Aeronautical Research Institute, Report No. 250*, Vol. 19, No. 1, January, 1945.) *U.S., N.A.C.A., Technical Memorandum No. 1351*, October, 1952. 74 pp., illus. 49 references.

Wing-Loading—What It Means in Air Warfare at 60,000 ft. James Hay Stevens. *Air Pictorial*, Vol. 14, No. 11, November, 1952, pp. 324–326, illus.

Airports

The Airport and its Neighbors—Report of the President's Airport Commission. *Journal of Air Law and Commerce*, Vol. 19, No. 2, Spring, 1952, pp. 221–230. 1 reference.

The Legal Framework of Airport Operations. L. Welch Pogue and James F. Bell. *Journal of Air Law and Commerce*, Vol. 19, No. 3, Summer, 1952, pp. 253–273. 80 references.

No Drinks for Transformers. L. C. Vipond. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 56–59, illus. Moisture-proofing underground transformers in airport lighting systems.

St. Louis' Terminal for Tomorrow. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 38, 39, illus. Details of plans for Lambert Municipal Airport.

Prestressed Concrete Hangars at London Airport. *The Engineer*, Vol. 194, No. 5049, October 31, 1952, pp. 579–581, illus.

Airport Lighting Made Safer. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 12–15, illus. Use of acrylic plastic sheet in high-intensity lighting.

Development of a Retractable Slope-Line Approach-Light Unit. Marcus S. Gilbert and H. J. Cory Pearson. *U.S., C.A.A., Technical Development Report No. 156*, January, 1952. 6 pp., illus. 1 reference.

An Experimental Counterrotating Marker Beacon. H. J. Cory Pearson and Marcus S. Gilbert. *U.S., C.A.A., Technical Development Report No. 160*,

pre-ci'sion—quality of being precise; accuracy; definiteness.
Kolls'man—masters of precision instrument making since 1929.

Synonyms

THE KOLLSMAN INSTRUMENT CORPORATION—designers, developers and manufacturers of precise, dependable instruments in the fields of:

Aircraft Instruments and Controls • Miniature AC Motors for Indicating and Remote Control Applications • Optical Parts and Optical Devices • Radio Communications and Navigation Equipment

While current facilities of our laboratories and plants are geared to production for National Defense, the planning divisions of Kollsman are ever active. And versatile Kollsman research engineers stand ready to assist America's scientists in the solution of instrumentation and control problems.

KOLLSMAN INSTRUMENT CORPORATION
ELMHURST, NEW YORK — GLENDALE, CALIFORNIA
SUBSIDIARY OF
Standard COIL PRODUCTS CO. INC.

February, 1952. 7 pp., illus. 2 references.

Modifications of the Slope Line Approach Light System. H. J. Cory Pearson. *U.S., C.A.A., Technical Development Report No. 167,* April, 1952. 8 pp., illus. 6 references.

Laboratory Compaction Tests of Coarse-Graded Paving and Embankment Materials. R. C. Mainfort and Warren L. Lawton. *U.S., C.A.A., Technical Development Report No. 177,* June, 1952. 23 pp., illus. 6 references.

The Measurement of Soil Moisture by Heat Diffusion. William M. Aldous, Warren L. Lawton, and Robert C. Mainfort. *U.S., C.A.A., Technical Development Report No. 165,* April, 1952. 17 pp., illus. 4 references. Runway design and maintenance application.

Air Traffic Control. Jerome Lederer (Moderator). *Skyways,* Vol. 11, No. 10, October, 1952, pp. 11–13, 38, 40–48, illus. (Flight Operations Round Table.)

Cossor Airfield Radar. Frank Coleman. *American Helicopter,* Vol. 27, No. 8, July, 1952, pp. 12, 13, 16, illus. Incorporates fuel circuit, approach-to-runway, and surface movement control.

The Development of Airport Taxi Guidance Signs. Marcus S. Gilbert and Robert E. Faucett. *U.S., C.A.A., Technical Development Report No. 170,* June, 1952. 10 pp., illus. 9 references.

Aviation Medicine

AF Reveals (T-1) High-Altitude Pressure Suit. *Aviation Week,* Vol. 57, No. 15, October 13, 1952, p. 17, illus.

Man From Mars? Nope—Man From Mojave!; T-1 High Altitude Pressure Suit Is Newest Pilot Protection Development. *Western Aviation,* Vol. 32, No. 11, November, 1952, p. 13, illus.

Men from Earth. *Flight Lines,* Vol. 3, No. 6, November, 1952, pp. 6, 7, illus. Air Force's T-1 upper atmosphere flying suit.

Putting on the Pressure. *Boeing Magazine,* Vol. 22, No. 10, October, 1952, pp. 12, 13, illus. Air Force's new pressurized suit, T-1, for use above 47,000 ft.

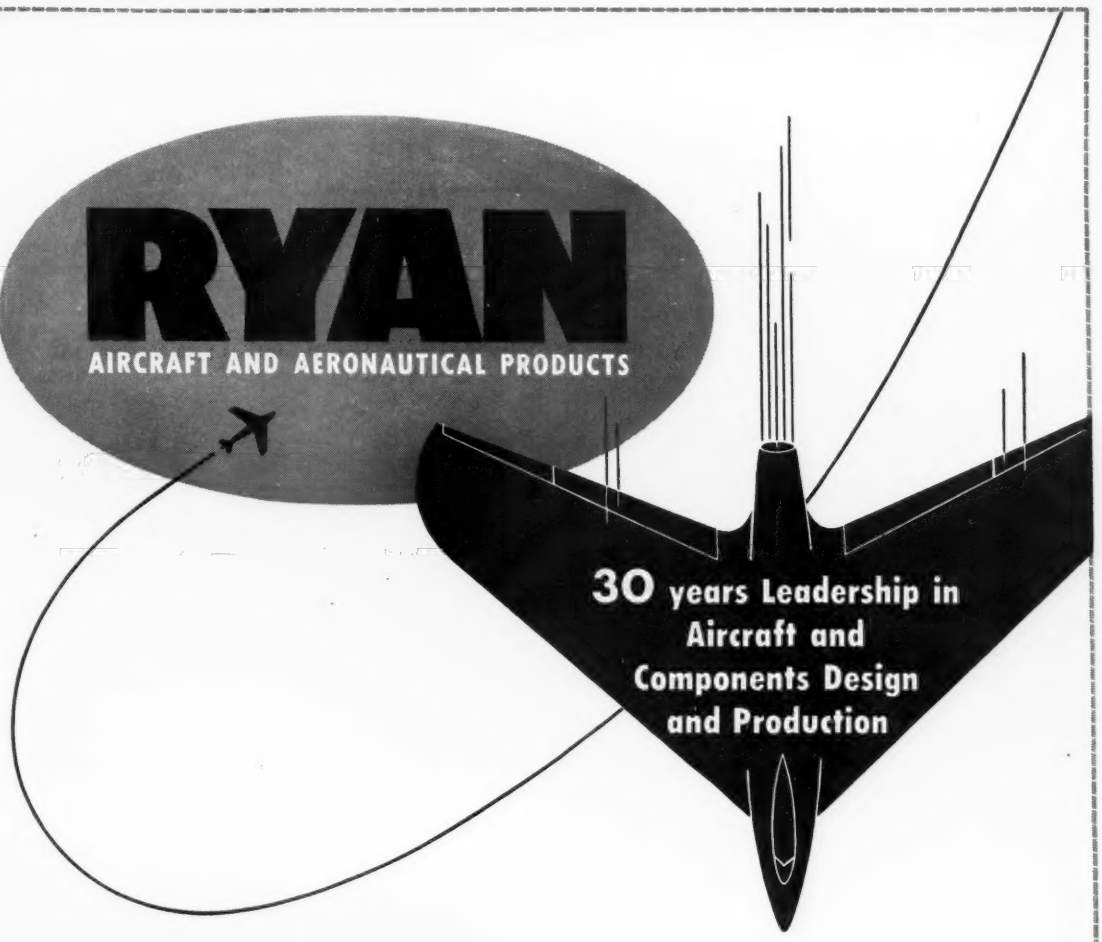
Effects of Acceleration Upon Cerebral Metabolism and Cerebral Blood Flow. Phase I—Development of a New Method for Continuous Measurement of Cerebral Blood Flow in Humans Under Acceleration. Richard L. Wechsler. *U.S., Naval Air Development Center, Aviation Medical Acceleration Laboratory, Johnsville, Penna., Report No. NADC-MA-5202,* August 15, 1952. 45 pp., illus. 11 references.

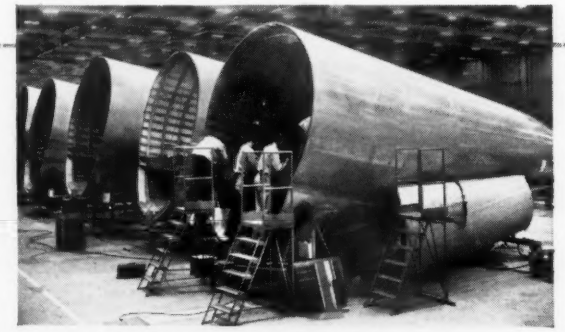
Exposure Hazard from Cosmic Radiation at Extreme Altitude and in Free Space. Hermann J. Schaefer. *American Rocket Society, Journal,* Vol. 22, No. 5, September-October, 1952, pp. 277–283, illus. 10 references. (Paper presented at A.R.S. Fall Meeting, Chicago, September 9, 1952.)

Manned Flight at the Borders of Space; The Human Factor of Manned Rocket Flight. Heinz Haber. *American Rocket Society, Journal,* Vol. 22, No. 5, September-October, 1952, pp. 269–276, 283, illus. 33 references. (Paper presented at A.R.S Fall Meeting, Chicago, September 9, 1952.)

RYAN

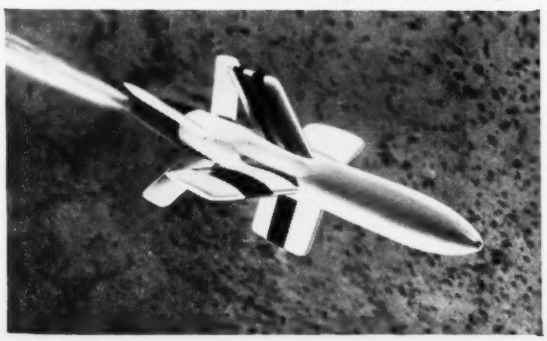
AIRCRAFT AND AERONAUTICAL PRODUCTS





FUSELAGES FOR BOEING C-97

RYAN'S AIR-TO-AIR "FIREBIRD" MISSILE



Thirty years experience in the aviation industry has well prepared Ryan for its present activities—activities that carry into virtually every field of aircraft development and production. From the manufacture of airframe components, huge fuel tanks and executive-liaison airplanes...to electronic-research and development...to high-speed pilotless aircraft and jet propulsion research, Ryan activities blanket the aircraft field.

VOLUME PRODUCTION OF AFT FUSELAGE SECTIONS for Boeing's C-97 Stratofreighter is typical of the components manufacturing work carried on for many years by Ryan's Airplane Division. For the C-97, Ryan also turns out refueling pods, cargo doors and floor beams.

THE FIRST RESEARCH MISSILE OF ITS TYPE to be revealed by the Air Force was Ryan's "Firebird" air-to-air guided missile. It has led Ryan into new developments in pilotless aircraft and electronics research. The XQ-2, now flying, is Ryan's new pilotless jet target plane with fighter plane performance.

AIRPLANE DIVISION

RYAN AERONAUTICAL COMPANY

LINDBERGH FIELD • SAN DIEGO, CALIFORNIA

The Effects of Pure Red and Low-Color-Temperature White Instrument Lighting upon Dark-Adapted Visual Thresholds. Kenneth T. Brown and Walter F. Grether. *U.S., Air Force, Technical Report No. 6470,* April, 1952. 18 pp., illus. 5 references.

Luminance Thresholds for the Resolution of Visual Detail During Dark Adaptation. Jack L. Brown, Clarence H. Graham, Herschel Leibowitz, and Howard B. Ranken. *U.S., Air Force, Technical Report No. 52-12,* January, 1952. 14 pp., illus. 11 references.

They're Off!—The Monkeys and the Mice; Physiological Research on Animals Leading to Human Space-Flight. *Western Aviation,* Vol. 32, No. 11, November, 1952, p. 12, illus.

World's Most Powerful Centrifuge Studies Human Tolerance to Acceleration. *Product Engineering,* Vol. 23, No. 8, August, 1952, pp. 188, 189, illus. Naval Aviation Medical Acceleration Laboratory equipment.

Computers

Decimal-Binary Conversion and Deconversion. A. van Wijngaarden. *Netherlands, Mathematisch Centrum, Amsterdam, Report No. R 130,* 1951. 41 pp.

Use of the Proposed Electric Isograph (Machine for Solving Polynomial Equations). K. Mitchell. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2411,* 1951 (August, 1945). 24 pp., illus. 9 references. British Information Services, New York. $1.50.

Designing Mechanical Computers. I—Functions Having Two Variables. II—Functions Having more than Two Independent Variables. Eugene W. Pike and Thomas R. Silverberg. *Machine Design,* Vol. 24, Nos. 7, 8, July, August, 1952, pp. 131–137; 159–163, illus. 7 references.

GEDA Computer Introduced to Western Aircraft Mftrs. *Western Aviation,* Vol. 32, No. 11, November, 1952, pp. 16, 18, illus. The Goodyear Electronic Differential Analyzer.

A System of Pulse Code Modulation Using Circulated Pulses. S. Fedida. *Electronic Engineering,* Vol. 24, No. 294, August, 1952, pp. 356–361, illus. 3 references.

The Notched-Disk Memory. Jacob Rabinow. *Electrical Engineering,* Vol. 71, No. 8, August, 1952, pp. 745–749, illus. Development by the National Bureau of Standards; applications.

CAA Type I Course Line Computer. Chester B. Watts, Jr., and Logan E. Setzer. *U.S., C.A.A., Technical Development Report No. 152,* January, 1952 21 pp., illus. 1 reference.

Electronic Analog Computer Fundamentals. Dewitt H. Pickens. *Electronics,* Vol. 25, No. 8, August, 1952, pp. 144–147, illus.

Engineering Uses of Analog Computing Machines. C. B. Crumb, Jr. *Mechanical Engineering,* Vol. 74, No. 8, August, 1952, pp. 635–639, illus. 14 references.

Digital Automatic Computer. *Mechanical Engineering,* Vol. 74, No. 11, November, 1952, pp. 914, 915, illus. Armed Forces' RAYDAC; application in guided-missile research.

More New Computers to Solve Defense Problems. *Product Engineering,* Vol. 23, No. 9, September, 1952, pp. 198, 199, illus. Navy's RAYDAC and teleplotter for guided-missile flight and other problems.

Raytheon Digital Computer "Worries" Over Solutions. *Aviation Age,* Vol. 18, No. 3, September, 1952, pp. 56–59, illus. Self-checking and other features of the RAYDAC.

The Whirlwind I Computer. R. R. Everett. *Electrical Engineering,* Vol. 71, No. 8, August, 1952, pp. 681–686, illus. Characteristics and probable improvements; high-speed equipment at the Digital Computer Laboratory, M.I.T.

Education & Training

Commercial Air Training. Partial Contents: From Fighter Pilot to Airline Captain. From Piston Engines to Jets, E. E. Rodley. Helicopter Pilot School, H. Boris. How to become an Air Hostess. Flight Simulators. Training Air Traffic Controllers. *Interavia,* Vol. 7, No. 11, November, 1952, pp. 607–627, illus. 2 references.

Curtiss-Wright Electronic (Dehmel Flight) Simulator. George Moore. *Aero Digest,* Vol. 65, No. 3, September, 1952, pp. 64–66, 68, 71, 72, 74, 76, 78, 80, 82, 84, 86, illus. Aid in advanced flight-path planning.

Gunnery Trainer Draws Electronic Bead. *Aviation Age,* Vol. 18, No. 4, October, 1952, pp. 6–8, illus. The Glenn L. Martin Company's T-13 flexible trainer.

Low-Flying Academy; The Training of Air O.P. and Liaison Pilots at Middle Wallop. *Flight,* Vol. 62, No. 2272, August 8, 1952, pp. 153, 156, illus.

Some Psychological Problems in Flying Training. W. T. V. Adiseshiah. *Indian Air Force Quarterly,* Vol. 2, No. 4, October, 1952, pp. 57–63, illus.

Electronics

CAA Type I Course Line Computer. Chester B. Watts, Jr., and Logan E. Setzer. *U.S., C.A.A., Technical Development Report No. 152,* January, 1952. 21 pp., illus. 1 reference.

An Omnirange Receiver Test System. Raymond E. McCormick, Kennard E. Voyles, and Blanchard H. Boyle. *U.S., C.A.A., Technical Development Report No. 162,* February, 1952. 4 pp., illus. 2 references.

Letters to the Editor: Current Noise in 100 Megohm Resistors. H. Bisby, L. H. Brown, and W. G. L. Brownrigg. *Electronic Engineering,* Vol. 24, No. 294, August, 1952, p. 385. 4 references.

Decommutating Pulse Telemetry. W. H. Chester and W. P. Klemens. *Electronics,* Vol. 25, No. 8, August, 1952, pp. 140–143, illus. The Bendix THC-1 electronic decommutator.

A Ten-Channel Pulse Code Telemetering System. A. J. Bayliss. *Electronic Engineering,* Vol. 24, No. 297, November, 1952, pp. 485–489, illus.

Calculation of Sky-Wave Field Strength. K. Rawer. *Wireless Engineer,* Vol. 29, No. 350, November, 1952, pp. 287–301, illus. 21 references.

A New Kind of Propagation at Very High Frequencies. *Franklin Institute, Journal,* Vol. 254, No. 5, November, 1952, pp. 417–420. 2 references.

Antennas

Mutual Radiation Resistance of Aerials and Arrays. H. Lottrup Knudsen. *Wireless Engineer,* Vol. 29, No. 350, November, 1952, pp. 301–305, illus. 20 references.

Some Considerations of Wide Aperture Localizer Antennas. Chester B. Watts, Jr. *U.S., C.A.A., Technical Development Report No. 155,* January, 1952. 10 pp., illus. 1 reference.

Trial and Evaluation of Trailing Antenna Modification on North Star Aircraft. B. G. Kuhn (Compiler). *Royal Canadian Air Force, Experimental and Proving Establishment, Rockcliffe, Report No. 969,* October, 1952. 19 pp., illus. 3 references.

A V-Type Aircraft Antenna. Raymond E. McCormick, Blanchard H. Boyle, and Kennard E. Voyles. *U.S., C.A.A., Technical Development Report No. 157,* February, 1952. 11 pp., illus. 10 references.

Circuits & Components

Instrument Electronics. XIV—Scientific & Industrial Instruments. Milton H. Aronson. *Instruments,* Vol. 25, No. 11, November, 1952, pp. 1572–1575, 1606, 1608, 1610, illus. Pickups, amplifiers, and output devices.

Special Rectifier Circuits; A Description of Some New High Voltage Circuits and Consideration of "Centre-tapped" Circuits. D. B. Corbyn. *Electronic Engineering,* Vol. 24, No. 295, September, 1952, pp. 418, 419, illus.

Important Design Factors Influencing Reliability of Relays. J. R. Fry. *Bell System Technical Journal,* Vol. 31, No. 5, September, 1952, pp. 976–998, illus. 9 references.

Wrapping Up an Electronic Computer. *Aviation Age,* Vol. 18, No. 4, October, 1952, pp. 9–11, illus. Ford Instrument Company's packaging system for easy installation of components.

A New Frequency Divider. J. A. Fitzgerald. *Electronic Engineering,* Vol. 24, No. 295, September, 1952, pp. 413–415, illus. Development of the balanced-modulator type.

Letters to the Editor: The Design of Series-Parallel Voltage Stabilizers. A. M. Andrew. *Electronic Engineering,* Vol. 24, No. 294, August, 1952, p. 385, illus.

Tape Wound Magnetic Cores. A. Langley Morris. *Electronic Engineering,* Vol. 24, No. 295, September, 1952, pp. 416, 417, illus.

Thermoelectric Generators. C. T. Chase. *Franklin Institute, Journal,* Vol. 254, No. 5, November, 1952, pp. 415, 416. Development for Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

Producing Barium-Titanate Transducers. *Electronics,* Vol. 25, No. 8, August, 1952, pp. 162, 166, 170, 174, illus.

WING and a PRAYER?

NO!

The Republic Thunderjet has an amazing record of sustaining heavy battle damage and still returning its pilot safely to base.

The Republic F84G, the first production fighter with provision for mid-air refueling, contains, as one of its most important components, Valcor actuating pilot valves. These valves, interspersed throughout the fuel system operate with great efficiency even when fluid is contaminated; the Valcor valves employ a floating shear seal that allows greater flow capacity for a given size solenoid, and function perfectly even under strong back pressure. These valves answered the engineering challenge of the rigid specifications for the newest Republic Thunderjet; they *surpassed* the specifications right across the board!

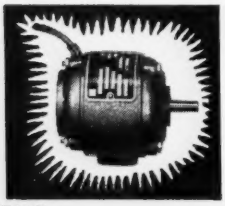
The Valcor Valve has achieved widespread acceptance in the aviation industry; there are, however, numerous other industrial uses for which the Valcor design can be adapted.

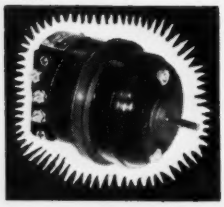
Submit your valve problems to Valcor—our engineering and research departments are at your disposal, without obligation. Send letter or blueprints. Booklet available.

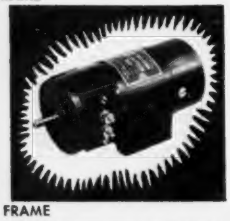
VALCOR ENGINEERING CORP.

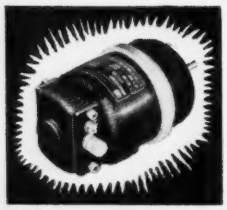
316 MARKET STREET • NEWARK, NEW JERSEY

WHEN YOU THINK OF *Instruments*
THINK OF **ELINCO**


BS FRAME


F FRAME


CB FRAME


FB FRAME

SUB-FRACTIONAL MOTORS AND GENERATORS

This time, try Elinco on that "special" problem of instrumentation. With hundreds of variations on over 600 basic models already manufactured, you may find that your special problem has been "pre-engineered" in the design files at Elinco. In tachometers, for instance, Elinco has developed countless high-precision variations of:

AC TACHOMETERS	DC TACHOMETERS
2-4-6-12 Poles	0.9 to 10 Volts at 100 r.p.m.
1-2-3 Phase	Voltage Output Linear
Standard Units	With Speed Within
Sine Wave Units	1% in Either Direction

FEATURES

Instrument-type precision ball bearings.
Every unit balanced dynamically . . . and *individually tested* under *specific load conditions.*
Ultra-precision manufacture of *all* parts.

PLUS

ANY physical or electrical variation to meet your specific requirements.
OVER 600 basic models with hundreds of variations already manufactured.

TYPES

AC • DC • Universal
Servo • Self-synchronous

RATINGS 1/3000 to 1/6 H P

PHASES One-, two-, and three-phase

WINDINGS

Compound • Shunt • Series
Separately Excited • Split Field
Permanent Magnet • Reluctance
Hysteresis • Stabilized Hysteresis
Induction • Drag Cup

SERVICES

1-, 2-, 3-, & 5-speed Synchronous
AC Dynamically Braked
Adjustable speed Governor-Controlled
Self-Starting Reversible

PLEASE

. . . outline your problem in *full* detail when requesting quotations or literature. We have NO STOCK UNITS, no "mass-produced" units available. Every ELINCO unit is a precision instrument, specially designed and manufactured to meet your highest specific performance standards.

ELINCO

ELECTRIC INDICATOR CO.

CAMP AVENUE • SPRINGDALE • CONN.

A V.H.F. Multi-Band Panoramic Receiver. E. W. Crompton. *Electronic Engineering*, Vol. 24, No. 297, November, 1952, pp. 478–484, illus. 7 references.

13 Ways to Use Magnetic Amplifiers. H. D. James. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 144–148, illus.

An A.G.C. Amplifier With Constant Output. A. B. Shone. *Electronic Engineering*, Vol. 24, No. 294, August, 1952, pp. 374–376, illus.

The Dielectric Amplifier. *Aerovox Research Worker*, Vol. 22, No. 8, August, 1952, pp. 1–3, illus. Basic circuits and principles.

A Series Magnetic Amplifier With Inductive Loading. T. G. Wilson. *Electrical Engineering*, Vol. 71, No. 8, August, 1952, p. 729, illus.

Power and Voltage Amplifiers; Fundamental Electronic Circuits. R. B. Immel. *Product Engineering*, Vol. 23, No 8, August, 1952, pp. 178, 179, illus.

A Stable, High Quality, Power Amplifier. E. J. Miller. *Electronic Engineering*, Vol. 24, No. 294, August, 1952, pp. 366, 367, illus. 5 references.

Variable Voltage Stabilizer Employing a Cold-Cathode Triode. F. S. Gouldings. *Electronic Engineering*, Vol. 24, No. 297, November, 1952, pp. 493–497, illus. 6 references.

Polyethylene Terephthalate (Mylar) as a Capacitor Dielectric. M. C. Wooley, G. T. Kohman, and William McMahon. *Electrical Engineering*, Vol. 71, No. 8, August, 1952, pp. 715–717, illus. 3 references.

The Miller Transitron; Grid Circuit Synchronization. O. C. Wells. *Electronic Engineering*, Vol. 24, No. 295, September, 1952, p. 407, illus. 2 references.

Properties of some High Titania Dielectric Ceramics. E. G. Graf. (*Ceramic Bulletin*, Vol. 31, No. 8, August, 1952, pp. 279–282.) *Engineers' Digest*, Vol. 13, No. 10, October, 1952, pp 341, 342, 364, illus.

Industrial Magnetrons for Dielectric Heating. Richard B. Nelson. *Electronics*, Vol. 25, No. 8, August, 1952, pp. 104–109, illus.

The Calculation of the Magnetizing Force. A. A. Halacsy. *Electrical Engineering*, Vol. 71, No. 8, August, 1952, p. 730, illus. 1 reference.

D-C (Electromagnetic) Brakes for A-C Motors. Robert C. May. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 156–160, illus.

Peak Coercive Force in Navy Magnet. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 29–31, illus. Bismanol—properties and applications.

Compensation of Feedback-Control Systems Subject to Saturation. I, II. George C. Newton, Jr. *Franklin Institute, Journal*, Vol. 254, Nos. 4, 5, October, November, 1952, pp. 281–296; 391–413, illus. 13 references. (Based on a Ph.D. thesis.) Analytical and theoretical aspects.

The "2000-OHM Milliammeter" Method for Daily Checking of L.T. Three-Phase Networks. M. Villain. (*Electricité*, Vol. 36, No. 181, March, 1952, pp. 59–63.) *Engineers' Digest*, Vol. 13, No. 8, August, 1952, pp. 267, 268, illus.

A Compact, Inexpensive A-C Network Analyzer. E. W. Kimbark, J. H. Starr, and J. E. Van Ness. *Electrical Engineering*, Vol. 71, No. 8, August, 1952, p. 722, illus. 2 references. The Northwestern University design.

Bridge Oscillator Has Linear Tuning. Abe Hershler and Benson Carlin. *Electronics*, Vol. 25, No. 8, August, 1952, pp. 134, 135, illus. 3 references.

The Design of Wire Wound Resistors. K. L. Selig. *Electronic Engineering*, Vol. 24, No. 294, August, 1952, pp. 372, 373, illus. 1 reference.

The Thermionic Constants of Metals and Semi-Conductors. I—Graphite. S. C. Jain and K. S. Krishnan. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1113, June 24, 1952, pp. 143–157, illus. 29 references.

Special Transitor Issue. *Institute of Radio Engineers, Proceedings*, Vol. 40, No. 11, November, 1952, pp. 1283–1602, illus. 393 references. 50 articles on semiconductors and electronic devices based on germanium and their applications.

Electrical Noise in Semiconductors. H. C. Montgomery. *Bell System Technical Journal*, Vol. 31, No. 5, September, 1952, pp. 950–975, illus. 14 references.

New Transistors Give Improved Performance. J. A. Morton. *Electronics*, Vol. 25, No. 8, August, 1952, pp. 100–103, illus. 5 references.

Transistors in Switching Circuits. A. Eugene Anderson. *Bell System Technical Journal*, Vol 31, No. 6, November, 1952, pp. 1207–1249, illus. 9 references.

Communications

The Analysis and Automatic Recognition of Speech Sounds. Caldwell P. Smith. *Electronic Engineering*, Vol. 24, No. 294, August, 1952, pp. 368–372, illus. 20 references.

Astraglossa or First Steps in Celestial Syntax. Lancelot Hogben. *British Interplanetary Society, Journal*, Vol. 11, No. 6, November, 1952, pp. 258–274, illus. A theoretical enlargement of the radio-lexicon of extra-terrestrial communication for interplanetary travel.

Identification of DME Transponders. Richard C. Borden and Carl C. Trout. *U.S., C.A.A., Technical Development Report No. 174*, June, 1952. 16 pp., illus. 8 references.

Electronic Controls

Electric Eye Corrects Tilting. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 138, 139, illus. Controlled output of an amplidyne generator supplying a transfer pump motor to correct tilting of the ram in hydraulic press brakes.

Magamp Regulation. *Mechanical Engineering*, Vol. 74, No. 11, November, 1952, pp. 915, 916, illus. A high-speed magnetic amplifier system.

Instrumentation. Ralph H. Munch. *Industrial and Engineering Chemistry*, Vol. 44, No. 11, November, 1952, pp. 93A, 94A, 96A, illus. Swartwout Autronic control systems.

New-Type A.C. Regulator Shown. Philip Klass. *Aviation Week*, Vol. 57, No. 16, October 20, 1952, pp. 63, 64, 66, illus. The Westinghouse AVR-22 mag-amplifier voltage unit.

Overload Relay for Motor Protection. L. E. Daehler. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 130–137, illus. Characteristics of thermal and magnetic overload types.

Electronic Tubes

Electron Tubes for Industry and Research. C. C. Gee. *Electronic Engineering, Electronics in Industry Supplement*, Vol. 24, No. 297, pp. 540–544. Classification tables.

Data-Displaying Cathode-Ray Tube. Joseph T. McNaney. *Electronics*, Vol. 25, No. 8, August, 1952, pp. 174, 178, 182, 186, illus. Charactrons; applications.

New Pulse Klystron Amplifier for the 960-1,215-Megacycle Region. Carol Veronda. *Electrical Engineering*, Vol. 71, No. 8, August, 1952, pp. 686–689, illus. 2 references. The SAL-39.

Some Events in the Early History of the Oscillating Magnetron. W. C. White. *Franklin Institute, Journal*, Vol. 254, No. 3, September, 1952, pp. 197–204, illus. 16 references.

A Study of the Characteristics of Glow-Discharge Voltage-Regulator Tubes. I. F. A. Benson. *Electronic Engineering*, Vol. 24, No. 295, September, 1952, pp. 396–401, illus. 15 references.

Measurements & Testing

Determination of the Velocity of Short Electromagnetic Waves by Interferometry. K. D. Froome. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1112, June 5, 1952, pp. 123–141, illus. 27 references.

Electrical Contact Resistance between Metallic Surfaces Subjected to Various Treatments. T. Fukuroi and Y. Muto. (*Tôhoku University, Japan, Science Reports of the Research Institutes*, Series A, Vol. 3, No. 3, June, 1951, pp. 281–291.) *Engineers' Digest*, Vol. 13, No. 8, August, 1952, pp. 261, 262, illus. Measuring circuit, apparatus, and procedure.

On the Diffusion Theory of Rectification. P. T. Landsberg. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1113, June 24, 1952, pp. 226–237, illus. 30 references. A uniform method of analyzing direct current-voltage curves of contact rectifiers.

Beta-Particle and Gamma-Ray Thickness Gauges. M. G. Hammett and H. W. Finch, *Electronic Engineering, Electronics in Industry Supplement*, Vol. 24, No. 297, November, 1952, pp. 536–539, illus.

Chart for Determining Acceleration from Vibrational Frequency and Amplitude. A. E. Maine. *Electronic Engineering*, Vol. 24, No. 294, August, 1952, p. 377, illus.

Gated Amplifier Wave Analyzer. V. Ronald Nelson. *Electronics*, Vol. 25, No. 8, August, 1952, pp. 136–139, illus.

The Du Mont Type 322; A New Dual-beam, General-purpose, Oscillograph. *The Oscillographer*, Vol. 13, No. 2, April–June, 1952, pp. 10–20, illus.

Impulse Corona Detection and Measurement. J. H. Hagenguth and T. W. Liao. *Electrical Engineering*, Vol. 71, No. 8, August, 1952, p. 706, illus.

A Linear Transducer for the Electrical Measurement of Displacement. M. J. Tucker. *Electronic Engineering*, Vol. 24, No. 295, September, 1952, pp. 420–422, illus. 2 references.

A Radio-Frequency Micropotentiometer. M. Lorant. *Electronic Engineering*, Vol. 24, No. 295, September, 1952, p. 415, illus.

A Simple Variable Frequency Phase Measuring Device. J. C. West and J. Potts. *Electronic Engineering*, Vol. 24, No. 295, September, 1952, pp. 402, 403, illus. 2 references. For measuring steady-state frequency response loci or Nyquist diagrams of four terminal networks.

600-Mc/s Field-Strength Meter. A. C. Gordon-Smith. *Wireless Engineer*, Vol. 29, No. 350, November, 1952, pp. 306–308, illus. 3 references.

Techniques of Measurement in Oscillography. II. P. S. Christaldi. *The Oscillographer*, Vol. 13, No. 2, April–June, 1952, pp. 3–9, illus. Observation and interpretation of the pattern; calibration of the cathode-ray oscillograph.

A Timing Circuit for Controlling Related High Energy Pulses. K. S. W. Champion and N. L. Allen. *Electronic Engineering*, Vol. 24, No. 295, September, 1952, pp. 423–425, illus. 2 references.

Two-Tube Square-Law Detector. David M. Goodman. *Electronics*, Vol. 25, No. 8, August, 1952, pp. 198, 202, 206, 210, 212, illus.

Vibration Test Setup. *Electronics*, Vol. 25, No. 8, August, 1952, pp. 244, 246, 248, illus. Sylvania Electric Products, Inc., testing of subminiature tubes.

Radar

Air Breakdown Chart for Radar Pulses. Harold A. Wheeler. *Electronics*, Vol. 25, No. 8, August, 1952, pp. 148, 150, illus. 5 references. Variation of breakdown voltage with frequency.

AN/APS-42. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, pp. 60, 62, 64, 66, illus. Houston Corp.'s role in developing the Navy's new transport radar.

Bright Display Equipment for Surveillance Radar. Albert W. Randall and Jack S. Marshall. *U.S., C.A.A., Technical Development Report No. 173*, June, 1952. 11 pp., illus. 3 references.

The Engineering of Radar Equipments Designed for the R.A.F. G. W. A. Dummer. *Electronic Engineering*, Vol. 24, No. 294, August, 1952, pp. 348–355, illus. 2 references.

The Effect of Radomes on Missile Guidance. E. T. Phillips. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 809.* 3 pp. 4 references.

Problems Associated with the Manufacturing of Radomes. J. A. Sporcic and R. L. Whann. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 807.* 17 pp., illus. 4 references.

Radome Anti-Icing Tests Instrumentation Problems Encountered. C. A. Gibbons. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 811A*, 13 pp., illus. 4 references.

Radome Optical System Problems on Supersonic Aircraft. W. Garcia. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 810*, 10 pp., illus. 3 references.

Radar Plumbing Can be Lightened. Philip Klass. *Aviation Week*, Vol. 57, No. 17, October 27, 1952, pp. 56, 58, illus. Faranti, Ltd.'s technique.

Transmission Lines

Mathematical Theory of Laminated Transmission Lines. I, II. Samuel F. Morgan, Jr. *Bell System Technical Journal*, Vol. 31, Nos. 5, 6, September, November, 1952, pp. 883–949; 1121–1206, illus. 49 references.

Broad-Band Coupling Unit for Power-Line Carrier With Associated Potential Device. J. A. Doremus, R. P. Crow, and W. H. Freeman. *Electrical Engineering*, Vol. 71, No. 8, August, 1952, pp. 707–713, illus.

Transmission-Line Capacitance and Voltage Gradient. H. B. Dwight and F., E. Scheidler. *Electrical Engineering*, Vol. 71, No. 8, August, 1952, p. 714, illus. 1 reference.

VHF Omnirange Wave Reflections from Wires. S. R. Anderson and H. F. Keary. *U.S., C.A.A., Technical Development Report No. 126*, May, 1952. 18 pp., illus. 1 reference.

Equipment

Components of Air Power. *Aeronautics*, Vol. 27, No. 3, October, 1952, pp. 34–38, illus. Examples of specialized products at the S.B.A.C. show.

Cheltenham Selection. *Aeronautics*, Vol. 27, No. 2, September, 1952, p. 105, illus. Descriptions of the Dowmic switch, Vardel pump, and other Dowty components.

Clutches. A. F. Gagne, Jr. *Machine Design*, Vol. 24, No. 8, August, 1952, pp. 123–158, illus. 31 references. Selection and application for optimum performance; design aspects.

Eaker Sees Fully Avionic Plane by '60. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, pp. 54, 56, 59, illus. Advantages and problems of systematic design of automatic equipment for a given aircraft.

Electric

Reliability of 28-Volt D-C Aircraft Distribution Systems. K. W. Carlson and E. S. Sherrard. *Electrical Engineering*, Vol. 71, No. 8, August, 1952, pp. 731–735, illus. 4 references. Integrated fault protection design; installation and maintenance program.

Short-Circuiting Techniques for Deactivating a Faulty Aircraft Generator. Oscar Markowitz and J. W. Pobst. *Electrical Engineering*, Vol. 71, No. 8, August, 1952, pp. 703–705, illus. 2 references.

Hydraulic

High Pressure Electro-Hydraulic (Hydel) Selector Valve. *Product Engineering*, Vol. 23, No. 9, September, 1952, p. 210, illus.

Hydraulics Play an Important Part in Jet-Propelled Bell X-5. Marvin M. McEuen. *Hydraulic Engineer*, Vol. 2, No. 4, October–November, 1952, pp. 3, 5, illus.

Over Travel of Straightening Press Prevented by Variable Delivery Pump. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 150, 151, illus. Developed by Hufford Machine Works, Inc., for straightening long sections of structural aircraft parts.

Safety Circuits for Hydraulic Machines. H. L. Stewart. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 124–129, illus.

Water Hammer in Hydraulic Systems. Harold K. Palmer. *Machine Design*, Vol. 24, No. 9, September, 1952, pp. 175–178, illus. Means of determining pressure-surge effects resulting from rapid valve closure.

Pneumatic

The Case for Pneumatic Power. Kenneth E. Allen. *Aero Digest*, Vol. 65, No. 2, August, 1952, pp. 48, 50, 52, 54, 56, illus. Accessory system drives.

Navy Development of Pneumatic Starting System for Gas Turbine Engines. A. K. Forney. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 813.* 12 pp., illus. 2 references.

Single-System Pneumatic Auxiliary Power. William J. Pattison. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 44, 45, illus. AiResearch Mfg. Co.'s 90° inward-flow radial turbines; comparison with other types.

Flight Operating Problems

Arctic Crossroads. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 46–49, illus. Air Force experience, instruments, methods, and problems of polar flight.

Long-Range Cruise Control. Keith L. Gimson. *Skyways*, Vol. 11, No. 12, December, 1952, pp. 14, 15, 54–56, illus. Range, fuel consumption, speed vs. power, mileage, and other aspects.

An Investigation of the Noise Field from a Small Jet and Methods for its Reduction. R. Westley and G. M. Lilley. *College of Aeronautics, Cranfield, England, Report No. 53*, January, 1952. 56 pp., illus. 10 references. 5*s*.

Analysing the Art of the Demonstration Pilot. John Derry. *Aeronautics*, Vol. 27, No. 2, September, 1952 pp. 129, 130, 133, illus.

Ice Prevention & Removal

Simple Graphical Solution of Heat Transfer and Evaporation from Surface Heated to Prevent Icing. Vernon H. Gray. *U.S., N.A.C.A., Technical Note No. 2799*, October, 1952. 19 pp., illus. (incl. folded chart on back cover). 20 references.

Thermodynamic Limitations of Ice Accretion Instruments. D. Fraser, C. K. Rush, and D. Baxter. *Canada, National Aeronautical Establishment, Low Temperature Laboratory, Report No. LR-32*, August 22, 1952. 26 pp., illus. 6 references.

A Method of Ice Protection for Radomes. F. E. Lenherr. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 811B.* 10 pp., illus. 4 references.

Radome Anti-Icing Tests Instrumentation Problems Encountered. C. A. Gibbons. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 811A.* 13 pp., illus. 4 references.

Development of the Ambassador Deicing System; An Account of a Series of Experiments Leading to a Satisfactory Installation. H. G. Newbigin. *Aircraft Engineering*, Vol. 24, No. 282, August, 1952, pp. 216–220, illus.

Flight Safety & Rescue

CAB (Elizabeth, N.J.) Accident Investigation Report. *Aviation Week*, Vol. 57, No. 16, October 20, 1952, pp. 68, 71, 72, 75, 76, 79, 83, 84.

Fuel Tank Purging Revealed. *Ryan Reporter*, Vol. 13, No. 5, August 1, 1952, pp. 6, 7, 23, illus. Inert gas systems to prevent fires and explosions.

Investigation of the Vulnerability of Aircraft Engine Oil Tanks to Accessory Section Fires. J. J. Gassman. *U.S., C.A.A., Technical Development Report No. 159*, February, 1952. 7 pp., illus.

Power Plant Fire Protection. W. E. Kavasch. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 825.* 6 pp., illus.

Thermistor Sensing Element Rids Aircraft Fire Detection System of False Alarms. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 134, 135, illus. Walter Kidde and Company's system.

Flight Testing

Flight Tests on the Youngman-Baynes High-Lift Experimental Aircraft. D. Lean. *Gt. Brit., Aeronautical Research Council, Current Papers No. 65*, 1952 (August, 1950). 54 pp., illus. 15 references. British Information Services, New York. $2.45.

Operational Experiences with Flying Test Bed Airplanes. H. B. Archer. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 835.* 6 pp.

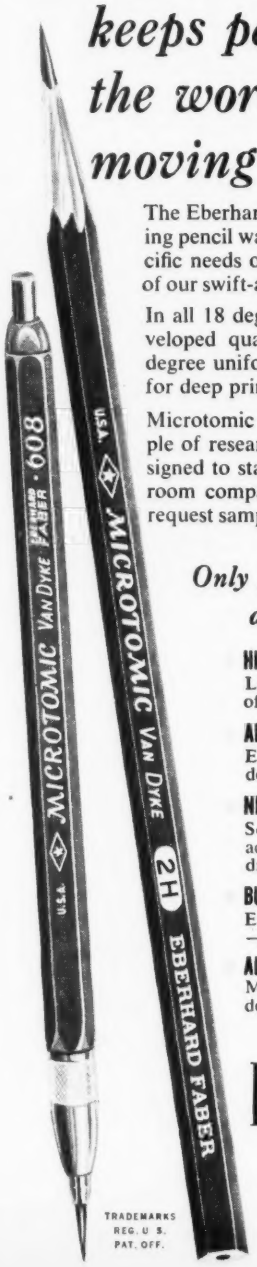
Timing and Phasing of Flight Testing in the Development of Engines. M. C. Benedict. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, Preprint No. 832.* 3 pp., illus.

Fuels & Lubricants

The Kinetics of the Oxidation of Gaseous Methyl Ethyl Ketone. I, II. J. Bardwell and Cyril Hinshelwood. *Royal Society (London), Proceedings, Series A,*

Microtomic

keeps pace with the world's fastest-moving industry



The Eberhard Faber Microtomic drawing pencil was designed to meet the specific needs of engineers and draftsmen of our swift-advancing aircraft industry.

In all 18 degrees, you'll find newly developed quality that assures absolute degree uniformity, plus an opaqueness for deep print clarity.

Microtomic represents the finest example of research in drawing pencils, designed to stand the most rigid drafting room comparisons. Test them today—request sample (specify degree wanted).

Only Microtomic gives you all these features

HI-DENSITY LEADS
Lines are opaque to actinic rays of high speed 'printers'.

ABSOLUTELY UNIFORM
Every Microtomic of the same degree marking is identical.

NEW DUSK GRAY
Scores of professional men acclaimed it the best color for a drawing pencil.

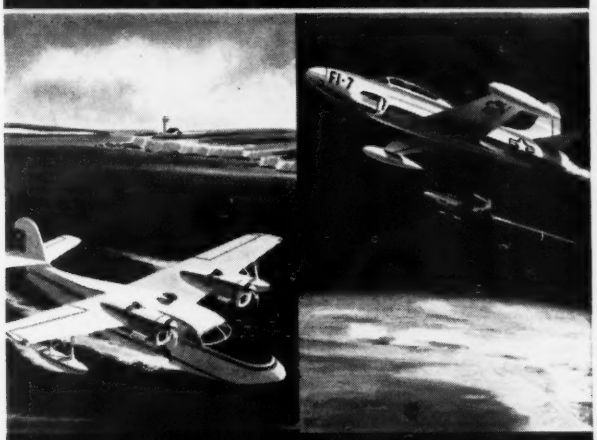
BULL'S-EYE DEGREE MARKING
Easier to read . . . quicker to find —positive identification.

ALSO—Choice of Holders and Microtomic Drawing Leads in all degrees.

EBERHARD FABER

since 1849

From Water Level To Stratosphere . . .



Pittsburgh FABSEAL

Makes Flying Safer . . . More Efficient!

Millions of flying hours prove the dependable performance of these impregnated fabric tapes in civilian and military use!

● Many of America's leading builders of aircraft use Pittsburgh's FABSEAL Tapes with complete confidence in their outstanding quality to seal flying boats, pressurized cabins and for other applications where there is considerable racking movement.

● FABSEAL Tapes are impregnated fabric of uniform density, resistant to water, gasoline and oil. They are available in .015″ thickness and in widths from ½″ to 12″, packages in rolls of 50 feet.

● These tapes are particularly designed for use in fluid or air containers where excessive pressures are experienced. They are also adapted for sealing structural members where flexibility and vibration present unusual requirements. FABSEAL Tapes can also be bolted, riveted or screwed between metal, wood or fiber members to provide a fillet that assures a complete seal.

● Call on us for advisory service. Our wide experience in the aircraft field often can save you time and money.

PITTSBURGH PLATE GLASS CO., Industrial Paint Div., Pittsburgh, Pa. Factories: Milwaukee, Wis.; Newark, N. J.; Springdale, Pa.; Houston, Texas, Los Angeles, Calif.; Portland, Ore. Ditzler Color Div., Detroit, Michigan. The Thresher Paint & Varnish Co., Dayton, Ohio. Forbes Finishes Division, Cleveland, Ohio. M. B. Suydam Div., Pittsburgh, Pa.

PITTSBURGH PAINTS

PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS

PITTSBURGH PLATE GLASS COMPANY

Standard-Thomson

Shut-off Valves

For fuel and hydraulic systems, Standard-Thomson Shut-Off Valves give three major advantages:

1. Standard-Thomson combines the proved sealing power of soft, synthetic rubber with a unique wear-saving device. During the entire valve cycle, the seals are *mechanically retracted*. The moving gate does not wear or bear on the seals.

2. For positive positioning of the gate, the unit embodies a *mechanical override* which disengages the actuator in full-open or full-closed position.

3. Use of a *uni-directional*, planetary gear actuator makes possible important savings in the design and cost of switching mechanism and motor.

- **Wear-saving, retracting seals**
- **Override for positive positioning of gate**
- **Simple, one-direction actuator**

Standard-Thomson Shut-Off Valves are furnished in diameters of 1″ to 3″, including a manually operated 2″ unit. The basic design can be adapted to shut-off service for any medium. For details, write:

STANDARD-THOMSON CORPORATION • DAYTON 2, OHIO

Standard-Thomson

Makers of USAF-approved bellows • valves • lights

Crankcase Pressurizing Valve | Barometric Pressure Valves | Tech-Forge Flexible Couplings | Vaporproof Cabin Lamp

Mathematical and Physical Sciences, Vol. 207, No. 1091, July 23, 1951, pp. 461–470; 470–482, illus. 19 references.

Some Phenomena of Engine Wear as Revealed by Radioactive Tracer Technique. H. R. Jackson, F. C. Burk, L. J. Test, and A. T. Cowell. *SAE Quarterly Transactions*, Vol. 6, No. 3, July, 1952, pp. 518–524; Discussion, pp. 524–530, illus. 7 references. (Paper presented at S.A.E., National Fuels and Lubricants Meeting, Chicago, November 1, 1951.)

Symposium on Petroleum. *Industrial and Engineering Chemistry*, Vol. 44, No. 11, November, 1952, pp. 2556–2650, illus. 308 references. (119th, 120th, 121st Meetings of the American Chemical Society, 1951, 1952.)

Petroleum Products: There'll Be Enough IF We Expand All Facilities in Proportion. C. E. Davis. *SAE Journal*, Vol. 60, No. 8, August, 1952, pp. 17–24, illus. (Excerpts from a paper presented at S.A.E., Summer Meeting, Atlantic City, June 5, 1952.) World production and consumption of gasoline, lubricating oils, and additives, excluding Russian-dominated areas.

Availability of Indigenous Vegetable Oils for Internal Combustion Engines in India. K. Mahadevan. *India, Institute of Science, Journal*, Vol. 34, No. 1 (Section B), January, 1952, pp. 1–7, illus. 6 references.

Handling Liquid Hydrogen Sulfide. W. O. Bice, Fred Prange, and R. E. Weis. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2497–2500, illus. 3 references. Phillips Petroleum Co.'s methods.

The Thermodynamics of Hydrocarbon Solutions. I—Technique of Vapour-Pressure Measurements; the Vapour Pressure of Benzene. P. W. Allen, D. H. Everett, and Mary Frances Penney. **II—The Systems Benzene+Diphenyl, Benzene+Diphenylmethane and Benzene+Dibenzyl.** D. H. Everett and Mary Frances Penney. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 212, No. 1109, April 22, 1952, pp. 149–176, illus. 53 references.

The Thermodynamics of Combustion Gases: General Considerations. Stuart R. Brinkley, Jr., and Bernard Lewis. *U.S., Department of the Interior, Bureau of Mines, Report of Investigations No. 4806*, April, 1952. 61 pp., illus. 23 references.

Activation Energies and Frequency Factors in the Thermal Decomposition of Paraffin Hydrocarbons. M. G. Peard, F. J. Stubbs, and Cyril Hinshelwood. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 119, October 9, 1952, pp. 471–481, illus. 9 references.

Carbon Formation in Flames of Aromatic Hydrocarbons. W. Sacks and M. T. I. Ziebell. *Canada, National Aeronautical Establishment, Fuels and Lubricants Laboratory, Report No. LR-30*, June 25, 1952. 14 pp., illus. 7 references.

Effect of Radiant Energy on Vaporization and Combustion of Liquid Fuels. A. L. Berlad and R. R. Hibbard. *U.S.*,

N.A.C.A., Research Memorandum No. E52I09, November 13, 1952. 46 pp., illus. 15 references.

Influence of External Variables on Smoking of Benzene Flames. Thomas P. Clark. *U.S., N.A.C.A., Research Memorandum No. E52G24*, August 29, 1952. 17 pp., illus. 4 references.

The Kinetics of the Thermal Decomposition of Branched-Chain Paraffin Hydrocarbons. I—*Iso*-Butane, *Iso*-Pentane and *Neo*-Pentane. II—The Isomeric Hexanes. M. G. Peard, F. J. Stubbs, and Cyril Hinshelwood. **Appendix—The Analysis of the Reaction Products.** C. J. Danby. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1118, September 23, 1952, pp. 330–343, illus. 7 references.

The Mode of Formation of Lead Deposits in Gasoline Engines. J. C. Street. *S.A.E., Fuels and Lubricants Meeting, Tulsa, Oklahoma, November 6–7, 1952, Preprint No. 859.* 22 pp., illus. 7 references.

NACA Investigation of Fuel Performance in Piston-Type Engines. Henry C. Barnett. *U.S., N.A.C.A., Report No. 1026*, 1951. 192 pp., illus. 13 references. Superintendent of Documents, Washington. $1.50.

The Role of Formaldehyde in the Oxidation of Ethylene. A. J. Harding and R. G. W. Norrish. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 212, No. 1110, May 7, 1952, pp. 291–311, illus. 21 references.

Some Factors Affecting Precombustion Reactions in Engines. M. W. Corzilius, D. R. Diggs, and D. L. Pastell. *S.A.E., Fuels and Lubricants Meeting, Tulsa, Oklahoma, November 6–7, 1952, Preprint No. 852.* 14 pp., illus. 6 references.

Filtering Superheated Alcoholic Solutions. A. W. Billitzer. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2417, 2418, illus.

National Annual Survey of Aviation Gasoline and Aviation Jet Fuel, October 1951 Production. O. C. Blade. *U.S., Department of the Interior, Bureau of Mines, Report of Investigations No. 4889*, May, 1952. 17 pp., illus. 5 references.

The Production and Utilisation of Methane as a Fuel in India. V. Aravamuthan. *Mechanical Engineer, Bangalore, India*, No. 1, October, 1950, pp. 50–58. 10 references.

Some Effects of Fuel Structure, Tetraethyl Lead, and Engine Deposits On Precombustion Reactions in a Firing Engine. Walter Cornelius and John D. Caplan. *SAE Quarterly Transactions*, Vol. 6, No. 3, July, 1952, pp. 488–508; Discussion, pp. 508–510, illus. 34 references. (Paper presented at S.A.E., National Fuels and Lubricants Meeting, Chicago, November 1, 1951.)

Spark Ignition; Effect of Molecular Structure. H. F. Calcote, C. A. Gregory, Jr., C. M. Barnett, and Ruth B. Gilmer. *Industrial and Engineering Chemistry*, Vol. 44, No. 11, November, 1952, pp. 2656–2662, illus. 5 references.

Synthesis of Alcohols by Hydrogenation of Carbon Monoxide. Robert B. Anderson, Julian Feldman, and Henry H. Storch. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2418–2424, illus. 28 references.

Vapor-Liquid Equilibria at 760 Mm. Pressure; 2-Propanol-Methanol, 2-Propanol-Ethyl Alcohol, 2-Propanol-Propanol, and 2-Propanol–2-Butyl Alcohol Systems. Louis H. Ballard and M. Van Winkle. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2450–2453, illus. 6 references.

Flame Velocities of Liquid Hydrocarbons. R. E. Albright, D. P. Heath, and R. H. Thena. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2490–2496, illus. 19 references.

On the Energy Equation for Fluid-Film Lubrication. A. Charnes, F. Osterle, and E. Saibel. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1116, August 7, 1952, pp. 133–136. 4 references.

Infrared-Intensity Measurements on Nitric Oxide, Hydrogen Chloride, and Hydrogen Bromide. S. S. Penner and D. Weber. *California Institute of Technology, Jet Propulsion Laboratory, ORDCIT Project, Progress Report No. 20-168*, January 15, 1952. 23 pp., illus. 19 references.

Bearings, Lubricants, and Lubrication; A Digest of 1951 Literature. *Mechanical Engineering*, Vol. 74, No. 11, November, 1952, pp. 885–891. 137 references.

Better Lubrication for Airport Trucks. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 28, 29, illus. Experience with Shell Rimula Oil in fire trucks.

The Correlation of Lubricating Oil Engine Test Procedures. R. Stansfield and J. G. Withers. *S.A.E., National Fuels and Lubricants Meeting, Tulsa, Oklahoma, November 6–7, 1952, Preprint No. 853.* 12 pp., illus. 7 references.

The Development of Rust Preventive Lubricating Oils for Reciprocating Aircraft Engines. E. F. H. Pennekamp and J. D. Oathout. *S.A.E., National Fuels and Lubricants Meeting, Tulsa, Oklahoma, November 6–7, 1952, Preprint No. 854.* 10 pp.

Diesters and the Properties Which Make Them Useful as Specialty Lubricants. V. W. Ware. *S.A.E., National Fuels and Lubricants Meeting, Tulsa, Oklahoma, November 6–7, 1952, Preprint No. 856.* 5 pp.

Engineering Possibilities of Synthetic Lubricants. W. A. Zisman. *S.A.E., National Fuels and Lubricants Meeting, Tulsa, Oklahoma, November 6–7, 1952, Preprint No. 855.* 20 pp., illus. 30 references.

Oil Has Small Effect on Combustion-Chamber Deposits. D. E. Carr, L. A. McReynolds, S. C. Britton, and R. E. Linnard. *SAE Journal*, Vol. 60, No. 8, August, 1952, pp. 32–34, illus. (Based on a paper presented at S.A.E., Annual Meeting, Detroit, January 17, 1952.)

Performance of Turbo Engine Synthetic Oils. A. B. Crampton, W. W. Gleason, W. E. Lifson, and E. F. H. Pennekamp. *S.A.E., National Fuels and Lubricants Meeting, Tulsa, Oklahoma, November 6–7, 1952, Preprint No. 857.* 13 pp. 7 references.

A Review of the Progress of Lubrication and Testing of Lubricating Oils in Internal Combustion Engines. K. Mahadevan. *Mechanical Engineer, Bangalore, India, No. 2*, December, 1951, pp. 26–33, illus. 16 references.

TCP Tests Look Good. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 29–31, illus. Service results on Shell Oil Co.'s Tricresyl Phosphate.

Behavior of Liquid Hydrocarbon with White Fuming Nitric Acid. C. H. Trent and M. J. Zucrow. *Industrial and Engineering Chemistry*, Vol. 44, No. 11, November, 1952, pp. 2668–2673, illus. 17 references. Liquid bipropellant systems and ignition processes.

The Effect of Variable Propellant Density On Rocket Performance. H. S. Seifert. *American Rocket Society, Journal*, Vol. 22, No. 4, July-August, 1952, pp. 213–215, illus.

Large-Scale Production and Handling of Liquid Hydrogen. H. L. Coplen. *American Rocket Society, Journal*, Vol. 22, No. 6, November-December, 1952, pp. 309–322, 338, illus. 7 references. (Presented at A.R.S. Session, 20th Annual Meeting, I.A.S., New York, February 1, 1952.) Research and development at Aerojet Engineering Corporation.

Gliders

New German Two-Seaters. Translated by G. S. Neuman. (*Thermik, No. 4*, 1952.) *Sailplane and Glider*, Vol. 22, No. 11, November, 1952, p. 18. The Doppelraab, Horten XV and XVC, Kranich III, and the ES-49.

Slingsby Type 34 Sky Single-Place Sailplane, England. T. A. Brown. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 128–131, illus.

Smolensk Motorless Single-Rotor Trainer Helicopter-Glider, U.S.S.R. *Sailplane and Glider*, Vol. 20, No. 9, September, 1952, p. 19.

Soaring in France; Gérard Pierre and the Fouga "C.M. 8-15." Guy Borgé. *Sailplane and Glider*, Vol. 20, No. 10, October, 1952, pp. 2, 3, illus.

Instruments

Determination of the Velocity of Short Electromagnetic Waves by Interferometry. K. D. Froome. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1112, June 5, 1952, pp. 123–141, illus. 27 references. Construction and application of a microwave interferometer in which the beam divider and the fixed arm are enclosed in a wave guide.

Micro-Interferometry for Surface Measurements. R. E. Sugg. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 156, 157, illus. Bausch and Lomb's equipment for measuring fine finishes.

Mechanical "Nose" Guards Jet Production. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 69–71, illus. Mine Safety Appliance Company's vapor analyzing and alarm instruments for safeguarding turbojet-engine test cells and fuel tanks.

Research vs Industrial Instrumentation. Delmas C. Little. *Instruments (Instrument Society of America, Journal* section), Vol. 25, No. 11, pp. 1587–1591, illus.

Wrapping Up an Electronic Computer. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 9–11, illus. Ford Instrument Company's packaging system for easy installation of components.

Development of an Automatic Counting Accelerometer. Cecil B. Phillips and Marvin J. Anderson. *U.S., C.A.A., Technical Development Report No. 166*, April, 1952. 12 pp., illus. 1 reference.

Automatic Flight with the (Lear) F-5. Jim Fahnestock. *Skyways*, Vol. 11, No. 10, October, 1952, pp. 27, 53.

Compensation of Feedback-Control Systems Subject to Saturation. I, II. George C. Newton, Jr. *Franklin Institute, Journal*, Vol. 254, Nos. 4, 5, October, November, 1952, pp. 281–296; 391–413, illus. 13 references. (Based on a Ph.D. thesis.) Analytical and theoretical aspects.

Eaker Sees Fully Avionic Plane by '60. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, pp. 54, 56, 59, illus. Advantages and problems of systematic design of automatic equipment for a given aircraft.

Radar Orders Fly (Westinghouse) W-3A Autopilot. Philip Klass. *Aviation Week*, Vol. 57, No. 15, October 13, 1952, pp. 46, 49, 52, 57, 59, 60, 62, illus. Target tracking and other design features; their use on Lockheed F-94C.

Sperry Weather. *Sperry Review*, Vol. 3, No. 5, Autumn, 1952, pp. 5–12, illus. Company's experience from 1913; automatic pilot, approach, and landing devices.

Better Engine Controls Through Iso-Elastic. *Aviation Age*, Vol. 18, No. 3, September, 1952, p. 33, illus. Bendix Aviation, Eclipse-Pioneer Division's electrically actuated Magnesyn indicators fitted with calibrated compression springs made of temperature-compensated Iso-Elastic alloy.

Ignition Analyzers Have Bright Future. *Aviation Age*, Vol. 17, No. 2, August, 1952, pp. 28–30, illus. Experience with airborne, ground, and portable types.

Modern Aircraft Fuel Gaging. Sanford Solarz. *Aero Digest*, Vol. 65, No. 3, September, 1952, pp. 40–42, 44, 46, 48, 50, 52, 54–56, illus.

Flight by Periscope. Stanley N. Roscoe. *Illinois, University, Institute of Aviation, Aeronautics Bulletin, No. 9*, 1951 (*Illinois, University, Bulletin, Vol. 48, No. 55*, 1951). 46 pp., illus. 9 references. Performing an instrument flight pattern.

Measurements of Temperature Variations in the Atmosphere Near the Tropopause with Reference to Airspeed Calibration by the Temperature Method. Lindsay J. Lina and Harry H. Ricker, Jr. *U.S., N.A.C.A., Technical Note No. 2807*, October, 1952. 23 pp., illus. 2 references.

Don't Disconnect that Meter. R. B. Buckius. *Instrumentation*, Vol. 6, No. 3, Fourth Quarter, 1952 pp. 30, 31, illus. The Brown "Differential Converter" flowmeter.

A Meter for Timing the Flow of Very Small Volumes of a Gas. J. C. Westmoreland. *U.S., N.A.C.A., Research Memorandum No. 52I09*, October 17, 1952. 17 pp., illus. 3 references.

Rupture-Proof Bellows-Type Orifice Meters. A. I. Thompson. *Instruments (Southern California Meter Association, Journal* section), Vol. 25, No. 11, November, 1952, pp. 1593–1596, illus. Construction, operation, and characteristics of flowmeters; applicability over a wide range of differential and static pressure.

Several Combination Probes for Surveying Static and Total Pressure and Flow Direction. Wallace M. Schulze, George C. Ashby, Jr., and John R. Erwin. *U.S., N.A.C.A., Technical Note No. 2830*, November, 1952. 64 pp., illus. 6 references.

A Simplified Laboratory Flow-Rator. T. Purnanandam and S. S. Ghosh. *India, Institute of Science, Journal*, Vol. 34, No. 2 (Section A), April, 1952, pp. 179–184. illus. 3 references. All glass, of the variable area type.

The Gyro Compass Explained; A Non-Mathematical Exposition of the Principles of the North-Seeking Gyro. *Sperry Review*, Vol. 3, No. 5, Autumn, 1952, pp. 13–17, illus.

The Effects of Pure Red and Low-Color-Temperature White Instrument Lighting upon Dark-Adapted Visual Thresholds. Kenneth T. Brown and Walter F. Grether. *U.S., Air Force, Technical Report No. 6470*, April, 1952. 18 pp., illus. 5 references.

Luminance Thresholds for the Resolution of Visual Detail During Dark Adaptation. Jack L. Brown, Clarence H. Graham, Herschel Leibowitz, and Howard B. Ranken. *U.S., Air Force, Technical Report No.* 52-12, January, 1952. 14 pp., illus. 11 references.

The Densities and Limiting Densities of Vapours. F. L. Casado, Doreen S. Massie, and R. Whytlaw-Gray. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 207, No. 1091, July 23, 1951, pp. 483–495, illus. 11 references. Combination of microbalance and multiple-point manometer for accurately comparing balancing pressures of vapors.

Development of a Photographic Instrument Recorder. Cecil Phillips. *U.S., C.A.A., Technical Development Report No. 163*, February, 1952. 11 pp., illus.

Four- and Eight-Channel Desynn Graphical Recorders. F. R. J. Spearman. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2636*, 1952 (March, 1948). 6 pp., illus. British Information Services, New York. $0.50.

Precision Raster Sweep Oscillograph. H. B. Steinhauser. *Electronics*, Vol. 25, No. 8, August, 1952, pp. 212, 214, 216, 218, 220, 222, illus.

Pulse Brightening Discrimination. A. L. Whitwell. *Electronic Engineering*, Vol. 24, No. 294, August, 1952, pp. 362–365, illus. Discriminator principle; application in a six-channel recorder.

Selective Erasure of Magnetic Tape Cross-Talk. Robert Herr and Robert A. von Behren. *Electronics*, Vol. 25, No. 8, August, 1952, pp. 114, 115, illus. 6 references.

Electric Servomechanisms in Design. Julius Y. Kaplan. *Machine Design*, Vol. 24, No. 7, pp. 157–162, 217, illus. (Based on a paper presented at the Greater N. Y. Chapter Meeting, American Society of Tool Engineers, May, 1952.) Basic analysis of closed-loop types.

Extensometer Contacts Bolt Ends in Tensile Test. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 140, 141, illus.

Half-Wave Magnetic Servo Amplifier. Carroll W. Lufcy, A. E. Schmid, and P. W. Barnhart. *Electronics*, Vol. 25, No. 8, August, 1952, pp. 124, 125, illus.

Simplifying Servomechanism Design. John M. Embree and Stephen P. Higgins, Jr. *Machine Design*, Vol. 24, No. 9, September, 1952, pp. 183–185, 260, 262, 264, 266, illus. (Based on a paper presented at the Semiannual Meeting, American Society of Mechanical Engineers, Cincinnati, June, 1952.) Coordinated analysis of design components by use of block diagrams.

(Vickers) Hydraulic Servo Systems. Norton Williams. *Aero Digest*, Vol. 65, No. 3, September, 1952, pp. 90, 92, 94, 96, 100, illus.

Application of Electric-Resistance Strain Gauges to Strain-Measurement in Ply-Wood Faces of Sandwich Panels. J. Solvey and G. L. Belcher. *Australia, Department of Supply, Aeronautical Research Laboratories, Structures and Materials Note No. 198*, June, 1952. 31 pp., illus.

Electric Resistance Strain Gages. J. A. Sweeney, Jr., and D. K. Schaeve. *Machine Design*, Vol. 24, No. 7, July, 1952, pp. 224, 226, 228, 230. (Based on a paper presented at the 4th Annual Meeting, American Institute of Electrical Engineers, Special Conference on Machine Tools, Rockford, Ill., November, 1951.)

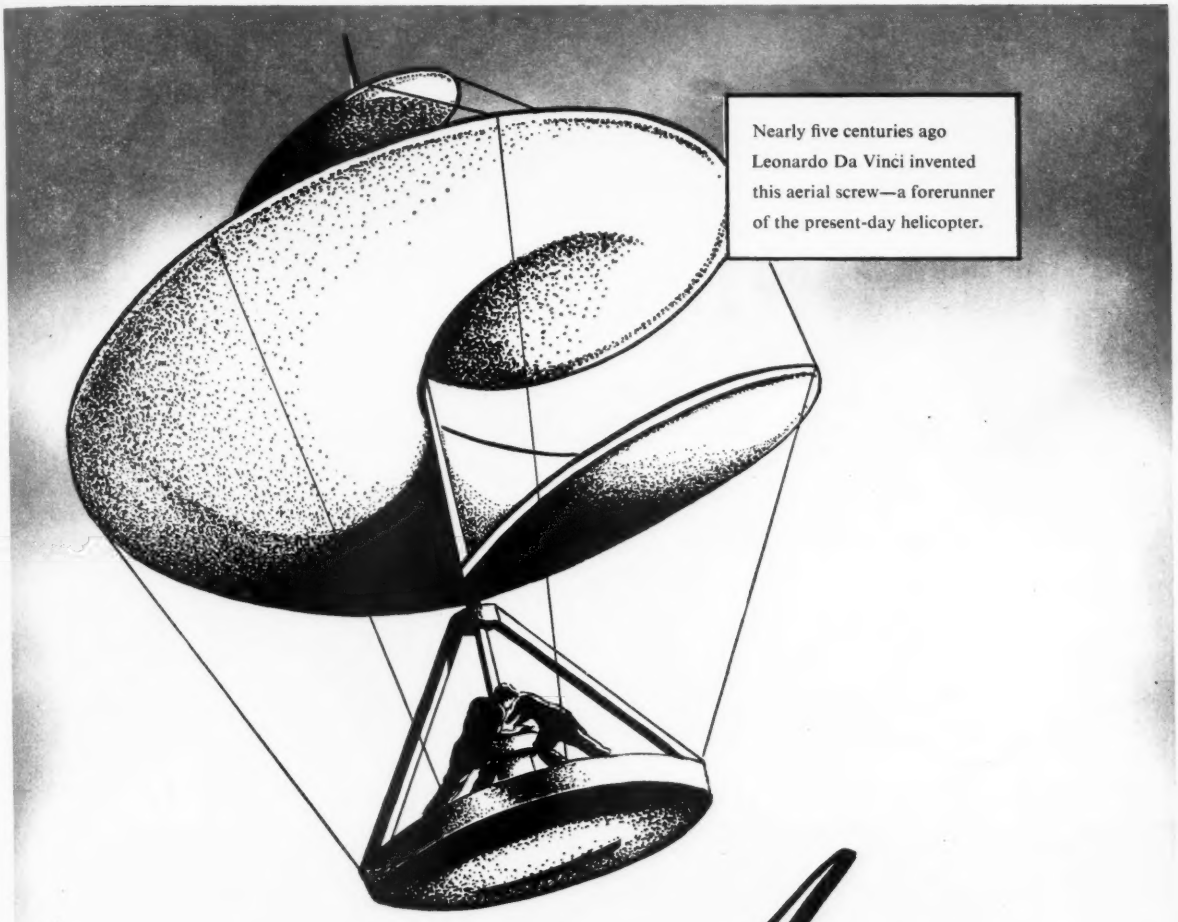
A New Electric Resistance Strain Gauge for Large Strain. N. L. Svensson. *Australia, Department of Supply, Aeronautical Research Laboratories, Structures and Materials Note No. 193*, September, 1951. 13 pp., illus.

A 24-way High-speed Rotary Switch for Use in Static and Airborne Strain Gauge Measurements. D. H. Peirson. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2232*, 1951 (November, 1946). 9 pp., illus. 4 references. British Information Services, New York. $0.75.

Properties of Strain Gauge Wires. R. P. Brown and N. L. Svensson. *Australia, Department of Supply, Aeronautical Research Laboratories, Structures and Materials Note No. 191*, September, 1951. 12 pp., illus. 3 references.

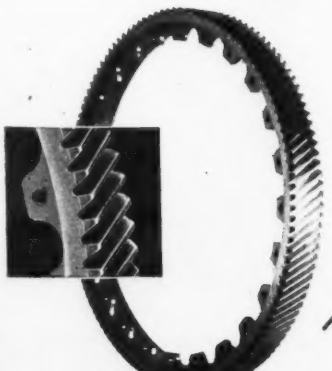
Temperature Measurement on Components Rotating at High Speeds. E. Fournel and C. Douchet. (*La Recherche Aeronautique, No. 27*, May-June, 1952, pp. 33–38.) *Engineers' Digest*, Vol. 13, No. 9, September, 1952, pp. 290–292, illus. 6 references.

A Dekatron Timer. J. McAuslan and K. J. Brimley. *Electronic Engineering*, Vol. 24, No. 295, September, 1952, pp. 408, 409, illus. 2 references. To measure delay of detonators from 25 millisec. and 12 sec.



Nearly five centuries ago Leonardo Da Vinci invented this aerial screw—a forerunner of the present-day helicopter.

... out of this came Aviation



...an industry with imagination

To serve this great industry there are many manufacturers with imagination and vision. Indiana Gear is such a company—a group of able craftsmen equipped with the best of tools and machines—producing the finest in precision parts. At I.G.W. we accept the challenge of this and all other precision industries. We will match their visionary design with creative production.

Indiana Gear fabricated this large steel ring gear for the main transmission of a recent model Sikorsky Helicopter without grinding and without heat treat distortion. Originally, the helical teeth on this gear were ground, but a necessary power increase overloaded the part and it failed.

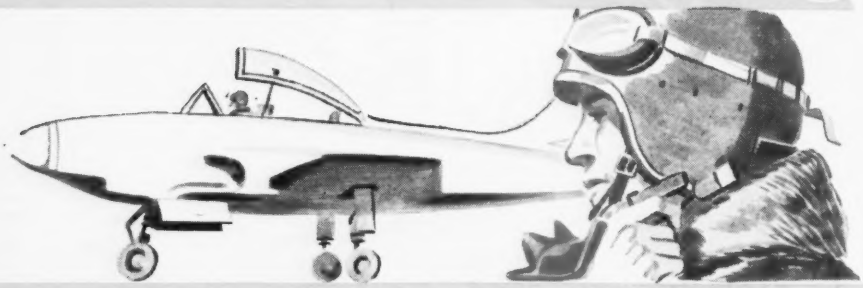
It was assumed to be impossible to successfully heat treat the unground teeth, but I.G.W. produced the part without distortion and the gear operated successfully.

INDIANA GEAR

INDIANA GEAR WORKS, INC. • INDIANAPOLIS 7, INDIANA

first in our planning...

THE MAN IN THE COCKPIT!



Since Korea multiplied an already heavy demand on our services, we at Eclipse-Pioneer have gone all-out to meet the new challenge. Besides greatly enlarging our own facilities, we've created a network of 23 complete unit sub-contractors and over 2300 first tier parts sub-contractors to help us deliver the goods. As a result, Eclipse-Pioneer production now stands at a record 514% of its pre-Korea level. But in all the acceleration of our plans . . . in all the haste to catch up with demand . . . we've never lost sight of one all-important fact. Our *first* responsibility is to the man on the spot—the man whose efficiency and, indeed, whose life depend so largely on the precision operation of our instruments and accessories. Because we cannot compromise quality with the pilot, our responsibility goes far beyond just multiplying manpower, equipment and facilities. In other words, our timetable for growth must *always* be based on the maximum that can be accomplished *without sacrifice in the high quality of our precision products!*

Eclipse-Pioneer

TETERBORO, NEW JERSEY • DIVISION OF Bendix AVIATION CORPORATION

WORLD'S LARGEST PRODUCER OF AVIATION INSTRUMENTS AND ACCESSORIES

Export Sales: Bendix International Division
72 Fifth Avenue, New York 11, N. Y.

PRECISION PRODUCTS* MADE BY ECLIPSE-PIONEER

Automatic Pilot and Flight Path Control Equipment • Airplane and Engine Instruments • Flight and Navigation Instruments • Power Supply Equipment • Air Pressurization and Ice Elimination Equipment • Engine Starting Equipment • Oxygen Equipment • Precision Components for Servomechanism and Computing Equipment • Sand, Permanent Mold and Die Castings of Magnesium and Aluminum • Plaster Mold Castings

*Manufacturing capacity is now available for a great many models of these products.

Aircraft Vibration Research. D. M. Corke. *Electronic Engineering, Electronics in Industry Supplement*, Vol. 24, No. 297, 1952, pp. 518–522, illus.

Laws & Regulations

Is Special Aviation Liability Legislation Essential? I, II. Edward C. Sweeney. *Journal of Air Law and Commerce*, Vol. 19, Nos. 2, 3, Spring, Summer, 1952, pp. 166–183; 317–337. 3 references.

The Legal Framework of Airport Operations. L. Welch Pogue and James F. Bell. *Journal of Air Law and Commerce*, Vol. 19, No. 3, Summer, 1952, pp. 253–273. 80 references.

Airspace Sovereignty Over Certain International Waterways. David Morgan Hughes. *Journal of Air Law and Commerce*, Vol. 19, No. 2, Spring, 1952, pp. 144–151. 20 references. Status of the Panama and Suez Canals and of the Dardanelles and Bosporus.

Comments by ICAO Council on the Liability Limits in Article II of the Mexico City Draft of the Convention on Damage Caused by Foreign Aircraft to Third Parties on the Surface. *Journal of Air Law and Commerce*, Vol. 19, No. 2, Spring, 1952, pp. 211–218. 2 references.

ICAO and Other Agencies Dealing with Air Regulation. Eugene Pepin. *Journal of Air Law and Commerce*, Vol. 19, No. 2, Spring, 1952, pp. 152–165. 12 references.

The International Air Navigation Conference, Paris 1910. John Cobb Cooper. *Journal of Air Law and Commerce*, Vol. 19, No. 2, Spring, 1952, pp. 127–143. 36 references.

Uniform Air Transport Documents and Conditions of Contract. J. G. Gazdik. *Journal of Air Law and Commerce*, Vol. 19, No. 2, Spring, 1952, pp. 184–208. 67 references.

Lighter-Than-Air

Goodyear XZPN-1 Twin-Engined Non-Rigid Blimp. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 65–68, illus.

Machine Elements

Case History: (Thompson Products) Ball-Joint Suspension. James H Booth. *SAE Journal*, Vol. 60, No. 8, August, 1952, pp. 39–41, illus. (Based on a paper presented at S.A.E., Annual Meeting, Detroit, January 18, 1952.)

Equipment and Design; Thrift by Design. Charles Owen Brown. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 85A, 86A, 88A, illus. Cooper Alloy Foundry Co.'s newly designed joint for iron pipe sizes up to $8^1/_2$ in.

Gasket Materials—Their Properties and Uses. Sidney G. Kelley, Jr. *Materials & Methods*, Vol. 36, No. 2, August, 1952, pp. 108–112, illus.

Bolt Loading. . .Can Be Made Uniform by New Technique and Thus Reduce Failures Caused by Erratic Effects of Torque Wrench. *SAE Journal*, Vol. 60, No. 8, August, 1952, p. 49, illus. (Based on a paper presented at S.A.E., Canadian Section, Toronto, January 22, 1952.)

How to Design Parts that Assemble and Lock by Twisting. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 162, 163, illus.

How to Provide for Backlash in Threaded Parts. Clifford T. Bower. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 154, 155, illus.

Square and Hexagon Bolt Standards. H. W. Robb. *Fasteners*, Vol. 8, No. 3, 1952, pp. 7–10, illus.

Friction of Clean Metals and the Influence of Adsorbed Films. F. P. Bowden and J. E. Young. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1094, September 7, 1951, pp. 311–325, illus. 16 references.

Metallic Transfer Between Sliding Metals: an Autoradiographic Study. E. Rabinowicz and D. Tabor. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1095, September 24, 1951, pp. 455–475, illus. 32 references.

Converting Decimal Fractions to Actual Gear Ratios. Gerald Smithson. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 158–161, illus. 4 references.

Nomograph to Simplify Gear Tooth Calculations. W. T. Winter. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 205, 207, 209, illus.

Standardisation of Worm Gears. W. A. Tuplin. *The Engineer*, Vol. 194, No. 5048, October 24, 1952, pp. 538–542, illus.

The Mechanical Push-Pull—A Remote Control for Industrial Use. Howard Holmes. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 152–155, illus.

Helical Spring Design. N. Sag. *Machine Design*, Vol. 24, No. 7, July, 1952, pp. 153–156, illus. 2 references. Charts for determining properties of circular and rectangular section wire.

Synthesis of a Nonlinear Dynamic Vibration Absorber. Robert E. Roberson. *Franklin Institute, Journal*, Vol. 254, No. 3, September, 1952, pp. 205–220, illus. 8 references. (Based on a Ph.D. thesis.)

Bearings

Experimental Investigation of Eccentricity Ratio, Friction, and Oil Flow of Short Journal Bearings. G. B. DuBois and F. W. Ocvirk. *U.S., N.A.C.A., Technical Note No. 2809*, November, 1952. 79 pp., illus. 7 references.

Investigation of 75-Millimeter-Bore Deep-Groove Ball Bearings Under Radial Load at High Speeds. I—Oil-Flow Studies. Zolton N. Nemeth, E. Fred Macks, and William J. Anderson. *U.S., N.A.C.A., Technical Note No. 2841*, December, 1952. 30 pp., illus. 10 references.

Investigation of Wear and Friction Properties Under Sliding Conditions of Some Materials Suitable for Cages of Rolling-Contact Bearings. Robert L. Johnson, Max A. Swikert, and Edmond E. Bisson. (*U.S., N.A.C.A., Technical Note No. 2384*, 1951.) *U.S., N.A.C.A., Report No. 1062*, 1952. 12 pp., illus. 11 references. Superintendent of Documents, Washington. $0.20.

Lubrication and Cooling Studies of Cylindrical-Roller Bearings at High Speeds. E. Fred Macks and Zolton N. Nemeth. (*U.S., N.A.C.A., Technical Note No. 2420*, July, 1951.) *U.S., N.A.C.A., Report No. 1064*, 1952. 15 pp., illus. 9 references. Superintendent of Documents, Washington. $0.20.

Bearings, Lubricants, and Lubrication; A Digest of 1951 Literature. *Mechanical Engineering*, Vol. 74, No. 11, November, 1952, pp. 885–891. 137 references.

Effects of Solid Inclusions in Sleeve-Bearing Oil Supply. H. Grady Rylander. *Mechanical Engineering*, Vol. 74, No. 12, December, 1952, pp. 963–966, illus. 3 references.

Selecting the Right Journal Bearing Material. E. H. Scott, Jr., and E. R. Booser. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 119–126, illus. 10 references. Requirements; summary of properties of materials.

Torque Tester for Small Ball-Bearings. *Product Engineering*, Vol. 23, No. 8, August, 1952, p. 208, illus.

The Use of Silver-Lead Alloys in Aircraft Bearings. T. R. Anantharaman. *Mechanical Engineer, Bangalore, India*, No. 1, October, 1950, pp. 33–38. 7 references.

Maintenance

Better Lubrication for Airport Trucks. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 28, 29, illus. Experience with Shell Rimula Oil in fire trucks; upkeep economy aspects.

Maintaining Airworthiness in Operation. R. E. Hardingham. *Royal Aeronautical Society, Journal*, Vol. 56, No. 503, November, 1952, pp. 819–840, illus. (The Eighth British Commonwealth and Empire Lecture.) Covers civil transport operations.

MATS Flying Repair Shop. *Aviation Age*, Vol. 17, No. 2, August, 1952, p. 41, illus. Military Air Transport Service's mobile maintenance aircraft; methods and equipment.

Repairing Reinforced Plastics. *Aero Digest*, Vol. 65, No. 2, August, 1952, pp. 20–23, illus. Naval Air Development Center's repair technique for radomes and other airborne electric equipment.

SAC Purchasing Know How. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 118–121. Parts sales and service methods of the Southwest Airmotive Company.

Test Equipment New Field. Julius Kendall. *Aero Digest*, Vol. 65, No. 3, September, 1952, pp. 114–126, illus. Greer Hydraulics, Inc.'s machine for aircraft inspection and maintenance.

Materials

Chemical Engineering Materials of Construction. Partial Contents: Aluminum Alloys, Harry W. Fritts. Ceramics, Felix Singer. Elastomers, Harry L. Fisher. Fibers, C. S. Grove, Jr., Joseph L. Vodonik, and Robert S. Casey. Nickel and Nickel-Base Alloys, H. O. Teeple. Plastics, G. M. Kline and R. B. Seymour. Hard Rubber, Henry Peters. Stainless Steels and Other Ferrous Alloys, Walter

Many products... One Standard

I.Q.*

*Instrument Quality

ACCELEROMETERS
Linear Transmitting

ANGULAR TRANSMITTERS
Pitch, Yaw, Pitot Static

GYROS
Free • Rate
Vertical • Directional

POTENTIOMETERS
Low Torque • Many types and resistance values

PRESSURE SWITCHES
Absolute • Differential Gage

PRESSURE TRANSMITTERS
Absolute • Differential Gage • (Resistance type)

STEPPING-POSITIONERS
Intermittent Rotary Power

TEMPERATURE DEVICES
For high or low temperature

There is one characteristic common to all Giannini instruments—they are built to rigid, instrument-quality standards. They are instruments with an earned reputation of offering the utmost in mechanical and electrical fineness—resulting from outstanding craftsmanship and rigorous calibration, testing and inspection procedures. Your job requirements can be met or exceeded by Giannini IQ instruments.

For catalog and engineering data on these and other fine instruments write:

INSTRUMENTS
CONTROLS

Giannini

G. M. GIANNINI & CO., INC., PASADENA, CALIFORNIA. EAST ORANGE, NEW JERSEY

A. Luce. Tin and Its Alloys, Robert J. Nekervis. Less Common Metals, L. F. Yntema and Wilfred R. Bekebrede. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2285-2380, illus. 2038 references. Recent developments in applications; tables of properties.

Helium: Bibliography of Technical and Scientific Literature From Its Discovery (1868) to January 1, 1947. Henry P. Wheeler, Jr., and Louise B. Swenarton. *U.S., Department of the Interior, Bureau of Mines, Bulletin No. 484*, 1952. 76 pp. 2616 references. Superintendent of Documents, Washington. $0.35. Breakdown by characteristics, chemistry, production, and utilization.

High-Speed Airplanes of Future Need New Materials; Materials Applications of Tomorrow. *Materials & Methods*, Vol. 36, No. 4, October, 1952, pp. 130, 131, illus.

Where Radioisotopes Are Finding Industrial Use. Philip O'Keefe. *Materials & Methods*, Vol. 36, No. 3, September, 1952, pp. 87-89, illus. Applications to research, selection, and testing.

Sandwich Construction and Core Materials. V—Section I: Some Physical Properties of an Extruded Cellular Cellulose Acetate; Section II: The Determination of Poisson's Ratio in Compression of Certain Low Density Materials. W. J. Pullen. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda, No. 2686*, 1952 (April, 1947). 14 pp., illus. 2 references. British Information Services, New York. $1.00.

Effects of Humidity During Fabrication of Polyester Laminates. John E. Wier, Dorothy C. Pons, and Benjamin M. Axilrod. (Based on *U.S., N.A.C.A. Research Memorandum No. 51C21*, 1951.) *Society of Plastics Engineers, Journal*, Vol. 8, No. 9, November, 1952, pp. 8-13, 27, illus. Includes tables of flexural strength properties.

Copper Sandwich. *Canadian Aviation*, Vol. 25, No. 8, August, 1952, p. 66. American Cladmetals Co.'s Rosslyn Metal; jet- and piston-engine applications.

Ceramics & Cermals

Ceramic Coatings Solve High Temperature Problems. John V. Long. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1-4, 1952, Preprint No. 821.* 12 pp., illus. 14 references.

New Ceramic Fiber: ... Resists High Temperatures...Is Excellent Insulator... (and) Has High Filtering Efficiency. *Materials & Methods*, Vol. 36, No. 3, September, 1952, pp. 94, 95, illus. Properties and applications of Carborundum Co.'s Fiberfrax.

Surface Finishes Improve Performance of Technical Ceramics. Hans Thurnauer. *Materials & Methods*, Vol. 36, No. 1, July, 1952, pp. 88-91, illus.

Which Nondestructive Test for Finding Defects in Ceramic Parts? Henry N. Staats. *Materials & Methods*, Vol. 36, No. 3, September, 1952, pp. 116-118, illus. (Based on a paper presented at Annual Meeting, Society for Non-Destructive Testing, October, 1951.)

Corrosion & Protective Coatings

Anticorrosive Primers; Pigments and Vehicles Applicable to Magnesium. Allen L. Alexander, Harold J. E. Segrave, Rodger Freriks, and J. E. Cowling. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2409–2414, illus. 10 references.

Control Galvanic Corrosion. . .Stop Costly Failures. E. C. Reichard. *Materials & Methods*, Vol. 36, No. 2, August, 1952, pp. 85–86, illus. 8 references. Methods; types of coatings.

Epoxide Resin Coatings Have Excellent Chemical Resistance, Adhesion (and) Abrasion Resistance Properties. T. R. Hopper. *Materials & Methods*, Vol. 36, No. 3, September, 1952, pp. 90–93, illus.

Grease Feedability Reduces Fretting Corrosion. E. W. Herbeck, Jr., and R. F. Strohecker. *Aviation Age*, Vol. 18, No. 3, September, 1952, pp. 6–16, illus. 20 references. (Based on a paper presented at the Fretting Corrosion Symposium of the American Society for Testing Materials, New York, 1952.)

A Metallographic Study of Pitting Corrosion Induced in 2S Aluminum Alloy by Exposure to Tap Water. E. C. Pearson, H. J. Huff, and R. H. Hay. *Canadian Journal of Technology*, Vol. 30, Nos. 10 and 11, October-November, 1952, pp. 311–316, illus. (9 plates). 17 references.

Rubber-Base Coating Resists Abrasion at High Aircraft Speeds. Bernard G. Floersch. *Materials & Methods*, Vol. 36, No. 5, November, 1952, pp. 184, 186, 188, illus. Use on Ryan jet-engine external fuel tanks.

Styrenation of Esters of Bisphenol-Epichlorohydrin Condensates. J. W. McNabb and Henry F. Payne. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2394–2397, illus. 23 references.

Aluminizing Protects Metals at Elevated Temperatures. L. E. Kunkler. *Materials & Methods*, Vol. 36, No. 4, October, 1952, pp. 210, 212, 214, illus. A metal-spraying process.

Chromate Protective Coatings. C. W. Ostrander. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 127–129, illus.

Corrosion. Mars G. Fontana. *Industrial and Engineering Chemistry*, Vol. 44, No. 11, November, 1952, pp. 101A, 102A, 104A, illus. Corrosion of 18-8S by nitric acid as a function of temperature.

Corrosion; Metals and Alloys for Handling Nitric Acid. Mars G. Fontana. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 101A, 102A, 104A, illus.

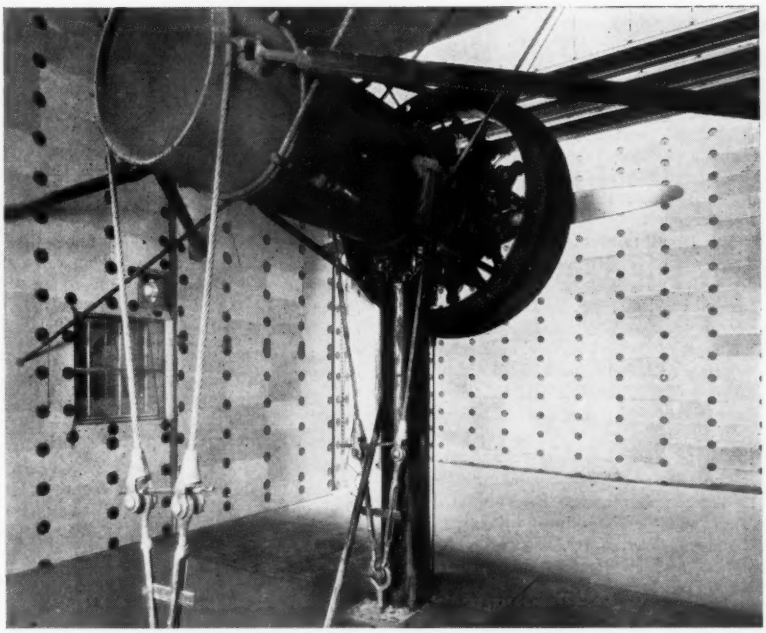
Hard Chromium Coatings for Ferrous Parts. G. A. Samuel. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 164–166, illus.

An Indentation Meter for Paint. J. Hoekstra and J. A. W. van Laar. (*Philips Technical Review*, Vol. 13, No. 12, June, 1952, pp. 352–359.) *Engineers' Digest*, Vol. 13, No. 8, August, 1952, pp. 249, 250, illus.

Reduction of Wear and Corrosion by Suitable Design and Choice of Materials. O. Niezoldi. (*Konstruktion*, Vol. 4, No.

ISC MAKES HISTORY...

WITH THE FIRST SUCCESSFUL TEST CELL FOR SILENCING AIRCRAFT PROPELLER TEST NOISE



Industrial Sound Control, collaborating with engineers of Hamilton Standard, Division of United Aircraft Corporation, installed at Hamilton in 1936 what is believed to be the first successful acoustical test cell in the United States. The photograph is of interest because it points up so dramatically the extent of present day progress.

The aircraft industry has made phenomenal strides since 1936, with a tremendous increase in horsepower and thrust, and an even greater increase in noise. ISC has paralleled these developments with constantly improved materials and techniques . . . and has continually added to its engineering skill and experience.

A recent example is ISC's new CERAM-ACOUSTIC heat- and corrosion-resistant treatment. An exclusive baked-on ceramic coating, which may be applied to ISC's "Soundmetal" panels, or to the new and revolutionary *Soundstream ® units, it withstands extreme temperatures without the need for cooling water.

ISC will design, engineer, manufacture and erect complete testing facilities, tailored to meet your specific requirements. Put ISC's "Silence Service" to work for you.

Foreign Licensees: Cementation (Muffelite) Limited, London
Les Travaux Souterrains, Paris

*Developed by BLEN Corporation — engineered, manufactured and installed by ISC.

SILENCE SERVICE

Industrial Sound Control Inc.

45 Granby Street, Hartford 12, Conn.

2119 SO. SEPULVEDA BLVD., LOS ANGELES, CALIF.

5, May, 1952, pp. 145–148.) *Engineers' Digest*, Vol. 13, No. 8, August, 1952, pp. 245, 246, illus.

Silver and Gold Plated Parts Meet Tough Specifications. T. C. Du Mond. *Materials & Methods*, Vol. 36, No. 5, November, 1952, pp. 114, 115, illus.

Some Newer Organic Protective Coatings. David Busker. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 167–174, illus. 18 references. Properties and applications of resin-base finishes.

Metals & Alloys

The Fulmer Research Institute. *The Engineer*, Vol. 194, No. 5046, October 10, 1952, p. 496, illus. Metallurgical research activities.

The Creep of Metals Under Interrupted Stressing. A. J. Kennedy. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1115, July 22, 1952, pp. 492–506, illus. 18 references.

The Ductility of Metals in Creep-Rupture Tests. H. H. Bleakney. *Canadian Journal of Technology*, Vol. 30, No. 12, December, 1952, pp. 340–351, illus. 14 references.

Effects of Cyclic Loading on Mechanical Behavior of 24S-T4 and 75S-T6 Aluminum Alloys and SAE 4130 Steel. C. W. MacGregor and N. Grossman. *U.S., N.A.C.A., Technical Note No. 2812*, October, 1952. 53 pp., illus. 4 references.

The Flow of Polycrystalline Metals Under Simple Shear. E. N. da C. Andrade and K. H. Jolliffe. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1112, June 5, 1952, pp. 3–26, illus. 11 references.

Catalysis on Evaporated Metal Films. I—The Efficiency of Different Metals for the Reaction Between Ammonia and Deuterium. C. Kemball. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1118, September 23, 1952, pp. 413–426, illus. 27 references.

Investigation of Statistical Nature of Fatigue Properties. E. Epremian and R. F. Mehl. *U.S., N.A.C.A., Technical Note No. 2719*, June, 1952. 119 pp., illus. 50 references. Survey of all aspects of the subject and review of the literature.

Magnetic Properties of Some Paramagnetic Crystals at Low Temperatures. Bhagawati Charan Guha. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 206, No. 1086, May 7, 1951, pp. 353–373, illus. 10 references.

Slip Planes and the Energy of Dislocations. B. Chalmers and Ursula M. Martius. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1113, June 24, 1952, pp. 175–185, illus. 29 references.

Some Magnetic Properties of Metals. III—Diamagnetic Resonance. IV—Properties of Small Systems of Electrons. R. B. Dingle. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 212, No. 1108, April 8, 1952, pp. 38–65. 18 references.

The Thermionic Constants of Metals and Semi-Conductors. I—Graphite. S. C. Jain and K. S. Krishnan. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1113, June 24, 1952, pp. 143–157, illus. 29 references.

The Valencies of the Transition Elements in the Metallic State. W. Hume-Rothery, H. M. Irving, and R. J. P. Williams. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1095, September 24, 1951, pp. 431–443, illus. 29 references.

How Lead-Clad Steel and Copper Extend Lead Applications. Alfred P. Knapp. *Materials & Methods*, Vol. 36, No. 4, October, 1952, pp. 115–117, illus.

Light Versus Heavy Metals and Alloys. J. Balachandra. *Mechanical Engineer, Bangalore, India*, No. 1, October, 1950, pp. 44–49. 11 references. Includes tables of basic data.

Solving Problems in Materials. T. S. Fuller. *American Society for Testing Materials, Bulletin*, No. 185, October, 1952, pp. 51–62, illus.

Aid for the High-temperature Designer. James Miller. *General Electric Review*, Vol. 55, No. 6, November, 1952, pp. 51–53, illus. New parameter to predict behavior of materials at high temperature; rupture characteristics of metals.

General Purpose High Temperature Alloys; What They Can Do, Where to Use Them. Kenneth Rose. *Materials & Methods*. Vol. 36, No. 4, October, 1952, pp. 103–107, illus.

The Heat's on Aero Engineers. *SAE Journal*, Vol. 60, No. 8, August, 1952, pp. 47–49, illus. Heat-resistant materials requirement for supersonic aircraft.

High Temperature Metallurgy. Bernard P. Planner. *Ryan Reporter*, Vol. 13, No. 5, August 1, 1952, pp. 16, 17, 24, 25, illus. Evaluation of properties and requirements; applications.

Machining High Temperature Alloys. P. G. DeHuff and D. C. Goldberg. *Machine Design*, Vol. 24, No. 9, September, 1952, pp. 270, 272, 274, 277, 278. (Based on a paper presented at the 20th Annual Meeting, American Society of Tool Engineers, March, 1952.) Physical properties; jet-engine applications.

New High Temperature Alloy. *Materials & Methods*, Vol. 36, No. 2, August, 1952, pp. 98, 99, illus. Characteristics and applications of Hastelloy X; comparison with Multimet (N155) alloys.

Powder Metallurgy Parts in High Temperature Applications. Julius J. Harwood. *Materials & Methods*, Vol. 36, No. 2, August, 1952, pp. 87–91, illus. 10 references. Also available in *Engineers' Digest*, Vol. 13, No. 10, October, 1952, pp. 334–356, illus. (Based on a paper presented at the Eighth Annual Meeting, Metal Powder Association, April, 1952.) New developments; applications in jet components.

Practical Applications of Hot Pressing. Jerome F. Kuzmick. *Materials & Methods*, Vol. 36, No. 1, July, 1952, pp. 84–87, illus. Molding metal powders.

Metals & Alloys, Ferrous

Effect of Chemistry and Section Size on Properties of Ductile Iron. D. J. Reese, F. B. Rote, and G. A. Conger. *SAE Quarterly Transactions*, Vol. 6, No. 3, July, 1952, pp. 385–394, illus. (Paper presented at S.A.E., Annual Meeting, Detroit, January 14, 1952.)

Effects of Slag Inclusions in Carbon Steels on Their Fatigue Strength. Tadasi Isibasi and Tsunemi Uryu. *Kyushu University, Japan, Research Institute for Applied Mechanics, Reports*, Vol. 1, No. 3, July, 1952, pp. 107–115, illus. 4 references.

An Engineering Method for Estimating Notch-Size Effect in Fatigue Tests on Steel. Paul Kuhn and Herbert F. Hardrath. *U.S., N.A.C.A., Technical Note No. 2805*, October, 1952. 35 pp., illus. 22 references.

The Iron-Nitrogen System: the Preparation and the Crystal Structures of Nitrogen-Austenite (γ) and Nitrogen-Martensite (α'). K. H. Jack. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1093, August 22, 1951, pp. 200–215, illus. 42 references.

The Occurrence and the Crystal Structure of α''-Iron Nitride; a New Type of Interstitial Alloy Formed During the Tempering of Nitrogen-Martensite. K. H. Jack. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1093, August 22, 1951, pp. 216–224, illus. 11 references.

Some Experiments on the Resistance of Metals to Fatigue under Combined Stresses. I, II. H. J. Gough, H. V. Pollard, and W. J. Clenshaw. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2522*, 1951 (June 28, 1949). 141 pp., illus. 31 references. British Information Services, New York. $10.25.

Some Problems in the Analysis of Steels by X-ray Fluorescence. E. Gillam and H. T. Heal. *British Journal of Applied Physics*, Vol. 3, No. 11, November, 1952, pp. 353–358, illus. 3 references.

Better Engine Controls Through Iso-Elastic. *Aviation Age*, Vol. 18, No. 3, September, 1952, p. 33, illus. Characteristics of Chattilon and Sons' temperature-compensated Iso-Elastic alloy; comparison with stainless steel.

Choosing Alternate Steels. H. B. Knowlton. *Machine Design*, Vol. 24, No. 7, July, 1952, pp. 217, 218, 220, 222, 224. (Based on a paper presented at the S.A.E., Annual Meeting, Detroit, January, 1952.) Causes of failure and other factors.

Factors in Selecting Stainless Steels. Basil T. Lanphier. *Machine Design*, Vol. 24, No. 7, July, 1952, pp. 112–128, illus. 3 references. Economic, conservation, utility, and efficiency considerations.

Materials & Methods Manual No. 85: Tool Steels: Uses, Types, Treatments. T. C. DuMond. *Materials & Methods*, Vol. 36, No. 2, August, 1952, pp. 113–128, illus.

Materials & Methods Manual No. 87: Carburizing of Steels. John L. Everhart. *Materials & Methods*, Vol. 36, No. 4,

Light Castings . . . These piston rings are produced in Ni-Resist for engines used in corrosive service.

Investigate NI-RESIST . . .

No other cast metal provides such a unique combination of useful engineering properties

NI-RESIST® is available nationwide in 5 basic types to meet a variety of industrial demands: resistance to corrosion, heat and wear; strength and toughness; good machinability; high electrical resistance and non-magnetic characteristics . . . as well as heat conductivity and controlled thermal expansion.

At the present time, nickel is available for the production of Ni-Resist and other alloys containing nickel, for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.

Medium Castings . . . Free from tendencies to corrode, comminutor parts cast in Ni-Resist lengthen life of sewage disposal equipment.

Heavy Castings . . . Casing, outer column and discharge head of this 14-ton pump are cast in Ni-Resist for resistance to salt water and other corrosive media.

SOURCES OF SUPPLY FOR NI-RESIST CASTINGS

EASTERN SECTION...

Abrasive Alloy Castings Co.
Bridgeboro, N. J.

American Abrasive Metals Co.
Irvington, N. J.

American Brake Shoe Co.
230 Park Avenue
New York 17, N. Y.

American Brake Shoe Co.
Engineered Castings Division
10 Mt. Read Blvd.
Rochester 11, N. Y.

American Chain & Cable Co., Inc.
Acco Casting Division
Reading, Pa.

The Baldwin-Lima-Hamilton Corp.
Eddystone Division
Paschall P. O.
Philadelphia 42, Pa.

Barnett Foundry & Machine Co.
536 Lyons Avenue
Irvington, N. J.

Curtiss-Wright Corp.
Metals Processing Division
162 Grider Street
Buffalo 11, N. Y.

Hunt-Spiller Manufacturing Corp.
383 Dorchester Avenue
South Boston 27, Massachusetts

Janney Cylinder Co.
7425 State Road
Philadelphia 36, Pa.

Koppers Company, Inc.
Metal Products Division
Bush & Hamburg Streets
Baltimore 3, Maryland

Kutztown Foundry & Machine Corp.
Kutztown, Pa.

Montague Machine Company
Turners Falls, Massachusetts

Olney Foundry, Link-Belt Co.
180 W. Duncannon Avenue
Philadelphia 20, Pa.

The Richmond Foundry & Mfg. Co., Inc.
Hermitage Road
Richmond 20, Illinois

The Taylor & Fenn Co.
Saville Street
Windsor, Connecticut

Weatherly Foundry & Mfg. Co.
Weatherly, Pa.

MIDDLE SECTION...

American Brake Shoe Co.
Electro-Alloys Division
1936 Taylor Street
Elyria, Ohio

American Cast Iron Pipe Co.
P. O. Box 2603
Birmingham 2, Alabama

Baker Perkins, Inc.
1000 Hess Street
Saginaw, Michigan

Carondelet Foundry Co
2101 S. Kingshighway
St. Louis 10, Mo.

Chicago Hardware Foundry Co.
2500 Commonwealth Avenue
North Chicago, Illinois

DeZurik Shower Co.
Foundry Division
Sartell, Minnesota

Duluth Brass Works Co.
5002 Ramsey Street
Duluth, Minnesota

The Duriron Co., Inc.
Dayton 1, Ohio

Engineering Castings, Inc.
405 South Linden
Marshall, Michigan

The Fahralloy Company
150th St. & Lexington Ave.
Harvey, Illinois

Frank Foundries Corp.
2020 Third Avenue
Moline, Illinois

The Hamilton Foundry & Machine Co.
1551 Lincoln Avenue
Hamilton, Ohio

Kingsport Foundry & Mfg. Corp.
East Sullivan and Main Streets
Kingsport, Tennessee

Michiana Products Corp.
P. O. Box 302
Michigan City, Indiana

Michigan Steel Casting Co.
1999 Guoin Street
Detroit 7, Michigan

Moran Flexible Joint Co., Inc.
215 West Main Street
Louisville 2, Kentucky

Reda Pump Co.
Bartlesville, Oklahoma

Ross-Meehan Foundries
1601 Carter Street
Chattanooga 1, Tennessee

St. Paul Foundry & Mfg. Co.
500 Como Avenue
St. Paul 3, Minnesota

Service Foundry Division
Avondale Marine Ways, Inc.
416 Erato Street
New Orleans 13, Louisiana

Shenango-Penn Mold Co.
Dover, Ohio

Standard Brass & Mfg. Co.
P. O. Box 1469
Port Arthur, Texas

The Sterling Foundry Co.
Wellington, Ohio

Texaloy Foundry Co.
1407 Hoefgen Avenue
San Antonio 3, Texas

The W. S. Tyler Co.
3615 Superior Avenue
Cleveland 14, Ohio

Wells Manufacturing Co.
7800 North Austin Avenue
Skokie, Illinois

WESTERN SECTION...

Centrifugal Casting Co.
3245 Cherry Avenue
Long Beach 7, California

Dameron Metal Sales Co.
927 South Sante Fe Avenue
Compton, California

Electric Steel Foundry Co.
2141 North West 25th Avenue
Portland 10, Oregon

Pacific Foundry Co., Ltd.
3100 19th Street
San Francisco 10, California

Stanley Foundries
6009 Sante Fe Avenue
Huntington Park, California

Utility Steel Foundry
3320 East Slauson Avenue
Vernon (L. A.) California

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC.

67 WALL STREET
NEW YORK 5, N. Y.

October, 1952, pp. 135–150, illus. Methods; heat treatment; properties and applications; causes of defects.

Materials Engineering File Facts No. 231: Summary of Standard Specifications for Steel Castings. *Materials & Methods*, Vol. 36, No. 1, July, 1952, pp. 121, 123.

Materials Engineering File Facts No. 234: Approximately Equivalent American and British Steel Specifications (Based on Composition). *Materials & Methods*, Vol. 36, No. 2, August, 1952, p. 135.

Materials Engineering File Facts No. 235: Materials Data Sheet; Manganese-Silicon and Manganese-Nickel-Chromium-Molybdenum Steels. *Materials & Methods*, Vol. 36, No. 3, September, 1952, p. 139.

Materials Engineering File Facts No. 236: Properties of Commonly Used Spring Materials. *Materials & Methods*, Vol. 36, No. 3, September, 1952, pp. 141, 143.

Materials Engineering File Facts No. 237: Comparative Specifications for Alloy Steels. *Materials & Methods*, Vol. 36, No. 4, October, 1952, pp. 153, 155, 157. U.S. military, aeronautical, and other federal requirements.

New Titanium-Boron Alloy Steel Shows Promise for Jets and Rockets. John L. Everhart. *Materials & Methods*, Vol. 36, No. 3, September, 1952, pp. 96–98, illus. 5 references.

Precipitation Hardening Steels Show Advantages in Aircraft. Gordon A. Fairbairn. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 829.* 8 pp., illus.

Use of High Tensile Steels in Aircraft. C. H. Stevenson. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 828.* 4 pp., illus.

Metals & Alloys, Nonferrous

Anomalous Paramagnetism of Copper Acetate. B. Bleaney and K. D. Bowers. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1119, October 9, 1952, pp. 451–465, illus. 19 references.

Penetration of Magnetic Fields into Superconductors. III—Measurements on Thin Films of Tin, Lead and Indium. J. M. Lock. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1094, September 7, 1951, pp. 391–408, illus. 18 references.

The Spontaneous Magnetization of Cobalt. H. P. Myers and W. Sucksmith. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 207, No. 1091, July 23, 1951, pp. 427–446, illus. 13 references.

Multi-Oscillator Processes in the Scattering of Neutrons by Crystals. G. L. Squires. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 212, No. 1109, April 22, 1952, pp. 192–206, illus. 12 references. Results obtained for nickel and magnesium.

The Reaction of Methane and Deuterium on Evaporated Nickel Catalysts. C. Kemball. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 207, No. 1091, July 23, 1951, pp. 539–554, illus. 12 references.

The Work Functions of Copper, Silver and Aluminium. E. W. J. Mitchell and J. W. Mitchell. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1100, December 7, 1951, pp. 70–84, illus. 22 references.

Chromium Carbide Meets Many Industrial Needs. J. D. Kennedy. *Materials & Methods*, Vol. 36, No. 2, August, 1952, pp. 166, 168, 170, 172, 174, illus. Corrosion- and heat-resistant properties.

Hard Metal Carbides. E. G. Ramachandran and M. V. Patankar. *Mechanical Engineer, Bangalore, India*, No. 1, October, 1950, pp. 26–28. Tungsten, tantalum, and titanium properties; applications.

Tungsten Carbide by Pyrolysis of Tungsten Hexacarbonyl. Dallas T. Hurd, H. R. McEntee, and P. H. Brisbin. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2432–2435, illus. 7 references.

Versatile New Fiber Insulates Jets. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 24–27, illus. Characteristics and applications of the Carborundum Company's Fiberfrax.

Hafnium Metal—Its Properties and Future. John L. Everhart. *Materials & Methods*, Vol. 36, No. 5, November, 1952, pp. 95–97, illus. 6 references. Comparison with zirconium and titanium.

Indium Alloys Finding Important Commercial Use. R. I. Jaffee and S. Marguerite Weiss. *Materials & Methods*, Vol. 36, No. 3, September, 1952, pp. 113–115, illus. 10 references. Properties; application in bearings, solders, and glass sealing alloys.

Materials Engineering File Facts No. 239: Materials Data Sheet; Lead-Base Babbits. *Materials & Methods*, Vol. 36, No. 5, November, 1952, pp. 145, 147.

Tantalum. N. R. Srinivasan. *Mechanical Engineer, Bangalore, India*, No. 1, October, 1950, pp. 29–32. 23 references. Characteristics; occurrence; new compounds.

Peak Coercive Force in Navy Magnet. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 29–31, illus. Bismanol—properties and applications.

The Effects of Re-Heat Treatment and Overheating on the Fatigue Properties of 24S Aluminium Alloy. J. Y. Mann. *Australia, Department of Supply, Aeronautical Research Laboratories, Report No SM. 185*, December, 1951. 15 pp., illus. 7 references.

The Inelastic Scattering of Very Slow Neutrons by Aluminium. J. M. Cassels. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1095, September 24, 1951, pp. 527–534, illus. 9 references.

"Today's Aluminum Aircraft Alloys." J. A. Nock, Jr. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 830.* 29 pp., illus. 12 references.

Rare Earth Metals Improve Elevated Temperature Properties of Magnesium Castings. J. C. McDonald. *Materials & Methods*, Vol. 36, No. 1, July, 1952, pp. 162, 164, 166, illus.

Alloyed-Titanium Tooling. James Joseph. *Aero Digest*, Vol. 65, No. 2, August, 1952, pp. 17–19, illus. Major problems.

Application of Titanium to Aircraft Engines. H. H. Hanink. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 755.* 14 pp., illus. Includes tables of cost and weight analysis and nominal compositions of components.

Titanium: Expensive Weight Saver. H. H. Hanink. *SAE Journal*, Vol. 60, No. 8, August, 1952, pp. 25–30, illus. (Based on a paper presented at S.A.E., National Aeronautic Meeting, New York, April 21, 1952.) Basic properties; jet- and piston-engine applications; design problems.

Titanium Specs; Air Industry Takes Step Toward Standardization. . . . William J. Coughlin. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, p. 18, illus.

Nonmetallic Materials

Electronic Levels in Simple Conjugated Systems. II—Butadiene. III—The Significance of Configuration Interaction. C. A. Coulson and Juliane Jacobs. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 206, No. 1086, May 7, 1951, pp. 287–296; 297–308, illus. 31 references.

The Frequencies and the Anharmonicities of the Normal Modes of Oscillation of Alkali Halide Crystals. I—Lattice Oscillations. II—Low-Frequency Acoustic Modes. K. S. Krishnan and Sanat Kumar Roy. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vols. 207, 210, Nos. 1091, 1103, July 23, 1951, January 22, 1952, pp. 447–460; 481–497, illus. 31 references.

Pressed and Sintered Nylon Powder Parts; A New Development. . . . Louis L. Stott and Laurence R. B. Hervey. *Materials & Methods*, Vol. 36, No. 4, October, 1952, pp. 108–111, illus. Properties; application in bearings, gears, cams, and other industrial products.

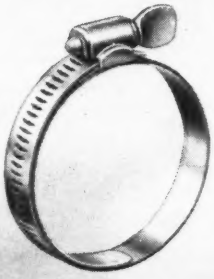
Properties and Composition of Glass Determined by Flow Measurements. P. Gilard, Jr. (*Revue Universelle des Mines*, 9th Series, Vol. 8, No. 8, August, 1952, pp. 320–324.) *Engineers Digest*, Vol. 13, No. 10, October, 1952, pp. 346, 347, illus.

Sorption and Surface Diffusion in Porous Glass. R. M. Barrer and J. A. Barrie. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1113, June 24, 1952, pp. 250–265, illus. 20 references.

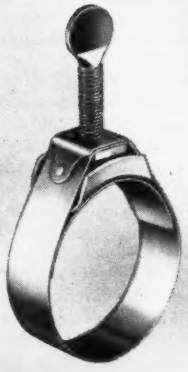
The Structure of Synthetic Polypeptides. III—The Molecular Configurations and Physical Properties of Some Regenerated Synthetic Polypeptides. C. H. Bamford, W. E. Hanby, and F. Happey. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 206, No. 1086, May 7, 1951, pp. 407–424, illus. 14 references.

A Theoretical Treatment of Cation Exchangers. I—The Prediction of Equilibrium Constants from Osmotic Data. E. Glueckauf. **II—Equilibria Between an Ion Exchanger and an Aqueous Solution with a Common Cation.** J. F. Duncan. *Royal Society (London), Proceedings, Se-*

BOEING
B-47 STRATOJET



AN737-TW TYPE WWD (Tangential—with one-piece housing)
AN737-RM TYPE FBSS (Radial—with floating bridge)



Equipped with

WITTEK

Aviation

HOSE CLAMPS

STANDARD OF THE INDUSTRY
FOR OVER A QUARTER CENTURY

WM CO.

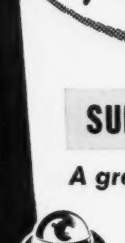
WITTEK MANUFACTURING COMPANY
4305-15 WEST 24TH PLACE • CHICAGO 23, ILLINOIS

SUB-MINIATURE
PILOT LIGHTS
Approved for AIRCRAFT
AND IMPROVED IN IMPORTANT DETAILS

DIALCO

SUB-MINIATURE INDICATOR ASSEMBLIES

A great aid to your miniaturization program



MOUNT IN 15/32" HOLE
ALL LENS COLORS

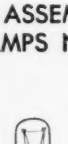
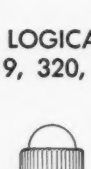
Easy lamp replacement with any midget flanged base lamp types

Complete blackout or semi-blackout dimmer types

NON-DIMMING
No. 8-1930-621

MECHANICAL DIMMER
No. 11-1930-621

THESE ASSEMBLIES LOGICALLY REPLACE
LAMPS NO. 319, 320, and 321

REPLACE WITH THIS  NOT THIS  OR THIS

PLASTIC PLATE (EDGE) LIGHT ASSEMBLIES

AIR FORCE and BUREAU of AERONAUTICS
MIL-L-7806 DRAWING MS-25010

DIALCO *No. TT-51* (Red filter-black top)
. . . or, *No. TT-51A*, complete with No. 327 Lamp

ALSO MADE
with other filter colors
and with *light-emitting top* (for indication)

ALL OF THE ASSEMBLIES ILLUSTRATED
ACCOMMODATE LAMPS NOS. 327, 328, 330, and 331.

ANY ASSEMBLY AVAILABLE COMPLETE WITH LAMP

SAMPLES ON REQUEST—NO CHARGE

Foremost Manufacturer of Pilot Lights
DIALIGHT CORPORATION
60 STEWART AVENUE, BROOKLYN 37, N. Y. HYACINTH 7-7600

© 1952

ries A, Mathematical and Physical Sciences, Vol. 214, Nos. 1117, 1118, August 21, September 23, 1952, pp. 207–225; 344–355, illus. 24 references. Analysis of ion-exchange phenomena in natural and synthetic materials.

Nylon—Its Properties and Applications. Robert Lurie. *Materials & Methods*, Vol. 36, No. 1, July, 1952, pp. 79–83, illus. 7 references.

What's New in Adhesives. Kenneth Rose. *Materials & Methods*, Vol. 36, No. 4, October, 1952, pp. 132–134, illus. Types; techniques of application.

Aspects of Polymerization at High Pressures. F. M. Merrett and R. G. W. Norrish. *Royal Society (London) Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 206, No. 1086, May 7, 1951, pp. 309–334, illus. 22 references. Analysis of vinyl compounds.

The Copolymerization of Styrene and Sulphur Dioxide. I—Properties and Composition of the Copolymer, and Evidence for the Existence of a Styrene/Sulphur Dioxide Complex. II—The Kinetics of Polymerization. W. G. Barb. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 212, Nos. 1108, 1109, April 8, 22, 1952, pp. 66–80; 177–192, illus. 40 references.

The Photo-Degradation of Polymethylmethacrylate. I—The Mechanism of Degradation. P. R. E. J. Cowley and H. W. Melville. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1103, January 22, 1952, pp. 461–481, illus. 13 references.

Studies in Chain Transfer. II—Catalyzed Polymerization of Methyl Methacrylate. Sadhan Basu, Jyotirindra Nath Sen, and Santi R. Palit. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1117, August 21, 1952, pp. 247–262, illus. 11 references.

Effects of Moderate Biaxial Stretch-Forming on Tensile and Crazing Properties of Acrylic Plastic Glazing. B. M. Axilrod, M. A. Sherman, V. Cohen, and I. Wolock. *U.S., N.A.C.A., Technical Note No. 2779*, October, 1952. 42 pp., illus. 14 references.

Aviation Takes to Plastics. Gilbert C. Close. *Aviation Age*, Vol. 18, No. 3, September, 1952, pp. 47–55, illus. Applications at Northrop and Douglas Aircraft Companies.

Delicate Parts Embedded in Compression Molded, Clear Plastics. Todd Harris. *Materials & Methods*, Vol. 36, No. 5, November, 1952, pp. 108, 109, illus.

Foam Plastic Is Lightweight Stiffener. *Aviation Week*, Vol. 57, No. 17, October 27, 1952, pp. 35, 36, 40, 43, 44, illus. Characteristics, applications, and tests of Lockheed's Lockfoam.

"Lockfoam" Filled-In-Place Structures. J. M. Gerschler. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 816.* 9 pp., illus. Properties; development.

New Transparent Plastics for Aircraft Enclosures. G. E. Hughes. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 817.* 5 pp.

How Plastics Cut F-84 Costs. Ben Sokol. *Aero Digest*, Vol. 65, No. 3, September, 1952, pp. 102–105, illus.

Foam and Foaming Liquids. V. Öhman. (*Teknisk Tidskrift*, Vol. 82, No. 14, April 8, 1952, pp. 317–322.) *Engineers' Digest*, Vol. 13, No. 9, September, 1952, pp. 295–297, illus. 20 references. Characteristics; selection.

Plastics for Metal Conservation. V. Aravamuthan. *Mechanical Engineer, Bangalore, India*, No. 2, December, 1951, pp. 50–53.

Repairing Reinforced Plastics. *Aero Digest*, Vol. 65, No. 2, August, 1952, pp. 20–23, illus. Naval Air Development Center's experience.

Teflon; Components and Coatings. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 149–153, illus. Tables of properties; applications.

Vinyl Plastisols and Plastigels; What They Are, Where They're Used. Philip O'Keefe. *Materials & Methods*, Vol. 36, No. 3, September, 1952, pp. 104–107, illus.

Elastomers—Rubber-Like Materials. Charles M. Miller. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 818.* 18 pp., illus. 6 references.

Neoprene Protective Coatings. L. S. Bake. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 138, 139, illus. Properties and applications.

New High Impact Styrenes. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 194–196, illus. Table of properties; applications.

Testing

***Bhn/E* × 10^6 = Modell = Measure of Wear Resistance.** T. L. Oberle. *SAE Journal*, Vol. 60, No. 8, August, 1952, pp. 42–46, illus. (Excerpts from a paper and discussion presented at S.A.E., Annual Meeting, Detroit, January 15, 1952.)

Hardness, Elastic Modulus, Wear of Metals. T. L. Oberle. *SAE Quarterly Transactions*, Vol. 6, No. 3, July, 1952, pp. 511–515; Discussion, pp. 516, 517, illus. 14 references. (Paper presented at S.A.E., Annual Meeting, Detroit, January 15, 1952.) The concept of "modell" to measure wear and the elastic limit of strain.

Black Light Spots Defects in Materials. N. E. Walters. *Materials & Methods*, Vol. 36, No. 5, November, 1952, pp. 105–107, illus.

Millionths for Precision. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 69–71, illus. Methods and gage blocks and other equipment used at Ryan Aeronautical Company to check accuracy of parts measurements.

Putting Ultrasonics to Work. Boyd Wise and Dale Ensminger. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 180–185, illus. Testing equipment and techniques, applications.

Meteorology

Aviation Weather. I. Peter E. Kraght. *Business Flying*, Vol. 1, No. 3, November, 1952, pp. 12, 13, 24, illus. First of a series of twelve articles covering fundamentals, weather-report reading, flying techniques, and other aspects.

Clouds Produced in an Expansion Chamber by Ultra-Violet Light. F. J. M. Farley. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 207, No. 1091, July 23, 1951, pp. 527–538, illus. 14 references.

"Project Cirrus"—The Story of Cloud Seeding. *General Electric Review*, Vol. 55, No. 6, November, 1952, pp. 8–26, illus. Survey of project; laboratory and field studies; overall results and implications.

The Jet Stream. William J. Kotsch. *U.S. Naval Institute, Proceedings*, Vol. 78, No. 12, December, 1952, pp. 1349–1353, illus.

Measurement of Winds in the Ionosphere. G. J. Phillips. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 3, 1952, pp. 141–154, illus. 17 references. Two-year study at the Cavendish Laboratory, on a 2.4 megacycles per sec. frequency.

A Radio Echo Method for the Investigation of Atmospheric Winds at Altitudes of 80 to 100 km. J. S. Greenhow. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 5, 1952, pp. 282–291, illus. 10 references.

Determination of Vertical Ozone Distribution at Various Latitudes During Eclipses of the Moon. H. K. Paetzold. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 3, 1952, pp. 183–188, illus. 9 references. In German.

On Fluctuations of Ozone in the Troposphere and Stratosphere. Erich Regener. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 3, 1952, pp. 173–182, illus. 12 references. In German.

Simultaneous Measurements of the Ozone Content of Air Near the Earth at Several Stations by Means of a Simple Absolute Method. Alfred Ehmert. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 3, 1952, pp. 189–195, illus. 7 references. In German.

The Morphology of Storms in the F_2 Layer of the Ionosphere. I—Some Statistical Relationships. E. V. Appleton and W. R. Piggott. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 4, 1952, pp. 236–252, illus. 5 references.

World-Wide Simultaneous Magnetic Fluctuations and Their Relation to Sudden Commencements. W. Jackson. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 3, 1952, pp. 160–172, illus. 7 references.

Measurements of Temperature Variations in the Atmosphere Near the Tropopause with Reference to Airspeed Calibration by the Temperature Method. Lindsay J. Lina and Harry H. Ricker, Jr. *U.S., N.A.C.A., Technical Note No. 2807*, October, 1952. 23 pp., illus. 2 references.

Point Discharge Currents. J. Alan Chalmers. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 5, 1952, pp. 301–305. 8 references. Analysis of their significance in maintaining the earth's charge.

The Relation Between Point Discharge Current and Field. J. Alan Chalmers. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 5, 1952, pp. 292–300. 7 references.

Theory of Formation of an Ionospheric Layer Below *E* Layer Based on Eclipse and Solar Flare Effects at 16 kc/sec. R. N. Bracewell. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 4, 1952, pp. 226–235, illus. 13 references.

The Use of a Simple Barograph in Cosmic Ray Balloon Flights. N. L. Allen and E. Pickup. *Canadian Journal of Technology*, Vol. 30, No. 12, December, 1952, pp. 317–320, illus. 3 references.

The Anomalous Propagation of Radio Waves in the 1–10 Metre Band. F. H. Northover. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 2, 1952, pp. 106–129, illus. 12 references.

An Explanation of Radio Propagation at *16* kc/sec in Terms of Two Layers below *E* layer. R. N. Bracewell and W. C. Bain. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 4, 1952, pp. 216–225, illus. 18 references.

Group Velocities and Group Heights from the Magneto-Ionic Theory. D. H. Shinn and H. A. Whale. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 2, 1952, pp. 85–105, illus. 21 references. Calculations for a radio wave in the ionosphere above South East England.

Research Notes: Polarization of Radio Waves Reflected from the Ionosphere. Bjørn Landmark. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 4, 1952, pp. 254, 255, illus.

A Search for Radio Echoes of Long Delay. K. G. Budden and G. G. Yates. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 5, 1952, pp. 272–281. 23 references.

Negative Electric Fields in Mist and Fog. J. Alan Chalmers. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 3, 1952, pp. 155–159, illus. 6 references. Investigation with transportable apparatus at Durham, England, in October, 1951.

The Graphical Representation of the Longitude Effect in F_2-Region. C. M. Minnis. *Journal of Atmospheric and Terrestrial Physics*, Vol. 2, No. 5, 1952, pp. 261–265, illus. 6 references.

The Diffraction of Galactic Radio Waves As a Method of Investigating the Irregular Structure of the Ionosphere. A. Hewish. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1119, October 9, 1952, pp. 494–514, illus. 16 references.

Military Aviation

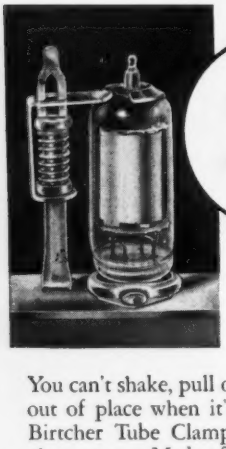
Air Defense of the United States. William G. Key. *Pegasus*, Vol. 19, No. 5, November, 1952, pp. 1–6, illus. Survey of aircraft, personnel, equipment, and other requirements.

Air Transportability with MATS (Military Air Transport Service). Joseph Smith. *American Society of Mechanical Engineers, Annual Meeting, New York, November 30–December 5, 1952, Paper No. 52-A-154.* 11 pp., illus. Developments in traffic and cargo operations; jet air-transportation factors; the Air Force's use of the Lockheed turboprop C-130.

Finland's Air Force Is Active. *Naval Aviation News*, November, 1952, pp. 22, 23, illus. Brief survey of aircraft, personnel, and other aspects.

BIRTCHER
TUBE CLAMPS
Hold Tubes in Sockets under all Vibration, Impact and Climatic Conditions

83 VARIATIONS FOR STANDARD TUBES



NEW CLAMP FOR MINIATURE TUBES

You can't shake, pull or rotate a tube out of place when it's secured by a Birtcher Tube Clamp. The tube is there to stay. Made of Stainless Steel, the Birtcher Tube Clamp is impervious to wear and weather.

BIRTCHER TUBE CLAMPS can be used in the most confined spaces of any compact electronic device. Added stray capacity is kept at a minimum. Weight of tube clamp is negligible.

Millions of Birtcher Tube Clamps are in use in all parts of the world. They're recommended for all types of tubes: glass or metal—chassis or sub-chassis mounted.

THERE'S A BIRTCHER TUBE CLAMP FOR EVERY STANDARD AND MINIATURE TUBE!

Write for samples, catalogue and price lists.

THE BIRTCHER CORPORATION
4371 Valley Blvd.
Los Angeles 32, Calif.

Forgotten Command. Maurice F. Allward. *Aeronautics*, Vol. 27, No. 2, September, 1952, pp. 119, 120, 122. 127, illus. Survey of the needs of the British Air Transport Command; comparison with U.S. counterpart.

Leadership in Long-Range Air War. Dale O. Smith. *Pegasus*, Vol. 19, No. 5, November, 1952, pp. 7–10, illus. Brief survey of strategic and tactical aspects.

NATO Air Power. Derek H. Wood. *Aeronautics*, Vol. 27, No. 2, September, 1952, pp. 107–110, 113, 115, 116. Review of resources; table of first-line aircraft.

A New Approach to the Deck-Landing Problem. W. L. Hicks. *Aeronautics*, Vol. 27, No. 3, October, 1952, pp. 40–43, illus. Basic difficulties of deck operations.

R.A.A.F.—Air Strength in the Pacific; Aussie Planes and Pilots. James H. Winchester. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 42, 43, illus.

Red Air Build-Up. *Aviation Age*, Vol. 17, No. 2, August, 1952, pp. 46, 47, illus. East German Zone bases and production centers.

The Soviet Aircraft Industry; Could Red Resources Support a Sustained Conflict? William Green. *Ordnance*, Vol. 37, No. 195, November-December, 1952, pp. 429–433, illus.

Soviet Black Sea Airbases. *Aviation Age*, Vol. 18, No. 3, September, 1952, pp. 25–27, illus. Locations; strategic importance.

The Turbojet, Ram-Jet and Rocket Air Force of the Future. Norman Macmillan. *Aeronautics*, Vol. 27, No. 1, August, 1952, pp. 24–31, illus. British problems of aerial armament in terms of aircraft development.

Missiles

Automatic Navigation of a Long Range Rocket Vehicle. H. S. Tsien, T. C. Adamson, and E. L. Knuth. *American Rocket Society, Journal*, Vol. 22, No. 4, July-August, 1952, pp. 192–199, illus. 4 references.

Readers' Forum: A Note on the Contribution of Configuration Asymmetries to the Free-Flight Motion of Missiles. John D. Nicolaides and Leonard C. MacAllister. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, p. 847, illus. 9 references.

Optimum Burning Program for Horizontal Flight. Albert R. Hibbs. *American Rocket Society, Journal*, Vol. 22, No. 4, July-August, 1952, pp. 204–212, illus. 5 references.

Calculation of the Stability of the Laminar Boundary Layer in a Compressible Fluid on a Flat Plate with Heat Transfer. E. R. Van Driest. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 801–812, 828, illus. 16 references. Lees-Lin theory applied; V-2 flight-temperature data illustrate use of stability results in missile aerodynamic heating analysis.

Thoughts On Rockets and Missiles. A. V. Cleaver. *Aircraft*, Vol. 30, No. 11, August, 1952, pp. 16–19, 46, illus., cutaway drawing. Survey of research, design specifications, and implications.

Letters to the Editor: Comment on "Heat Flow in Composite Slabs" by E. Mayer. Jack Lorell. *American Rocket Society, Journal*, Vol. 22, No. 4, July-August, 1952, pp. 215, 222. 2 references.

Current Problems in Guided Missile Instrumentation. H. M. Cobb. *Photographic Engineering*, Vol. 3, No. 3, 1952, pp. 119, 120. 1 reference.

Navigation

The Air Navigation Development Board; Its Objectives, Accomplishments and Program. Bert A. Denicke. *Navigation*, Vol. 3, No. 5, September, 1952, pp. 153–158, illus. 5 references. (Paper presented at 8th Annual Meeting, Institute of Navigation, San Francisco, June 26, 1952.)

The Accuracy of Bubble Sextant Observations. A. J. Hagger. *Institute of Navigation, Journal*, Vol. 5, No. 4, October, 1952, pp. 380–420, illus. 5 references. Aeroplane and Armament Experimental Establishment, Navigation Section developmental investigations.

Astrograph-time Star Tables for Air Navigation. Philip Ashton. *Institute of Navigation, Journal*, Vol. 5, No. 4, October, 1952, pp. 377–379.

Ordnance & Armament

"Atypical" Aircraft Armament; Germany's Last World War II Guns. Roger Marsh. *Aviation Age*, Vol. 18, No. 5, November, 1952, p. 45, illus.

AIRSURANCE
Airline Passenger Insurance
Annual Policies from $5,000 to $100,000 at new low rates
No Physical Examination • No Age Limit
EXAMPLE
$25,000.00 for death or dismemberment
$1,000.00 for Hospital and Doctor's bills
$50.00 per week when disabled
PREMIUM $38.00 per year
Policies cover passengers on scheduled airlines world-wide — also airlines in Canada, Mexico and South America which meet safe operating standards.
Backed by the Combined Assets of
Aetna Casualty & Surety Co.
American Surety Co. of N. Y.
Century Indemnity Company
Hartford Accident & Indemnity Co.
Maryland Casualty Co.
Massachusetts Bonding & Insurance Co.
New Amsterdam Casualty Co.
Standard Accident Insurance Company
Travelers Insurance Co.
United States Casualty Co.
United States Fidelity & Guaranty Co.
U.S. GROUP
WRITE OR PHONE ANY U. S. GROUP OFFICE
UNITED STATES AVIATION UNDERWRITERS
INCORPORATED
80 JOHN ST. • NEW YORK 38, N. Y.
ATLANTA · CHICAGO · DALLAS · KANSAS CITY
LOS ANGELES · SAN FRANCISCO

Design of Radomes Resistant to Gun Blast. H. A. Hummel. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 808.* 8 pp., illus.

Parachutes

Parachute Jumping—from Sailplanes. George Curiel. *Sailplane and Glider*, Vol. 20, No. 10, October, 1952, pp. 6–8.

Personal Flying

Business Flying Is Cheap Transportation. Leslie A. Bryan. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 115–117. Survey of operating costs of light aircraft; tabular breakdown by types and cost items.

Private Flying: A Diagnosis. A. A. Boon Hartsinck. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 123–127, illus. Development since 1927.

Photography

Development of a Photographic Instrument Recorder. Cecil Phillips. *U.S., C.A.A., Technical Development Report No. 163*, February, 1952. 11 pp., illus.

High-Speed Photography. Kenneth Morgan. *Interchemical Review*, Vol. 11, No. 3, Autumn, 1952, pp. 59–70, illus. Fundamental principles, procedures, and equipment; applications of schlieren and other techniques.

High Speed Photography in Design. C. David Miller. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 167–182, illus., folding chart. 10 references. Types, operation, and cost of equipment; applications to study of piston-engine knock, vibration in structures, and fluid flow through impellers; high-speed camera systems and techniques.

Photographic Instrumentation and a Proposed System of Organization. Kenneth Shaftan. *Photographic Engineering*, Vol. 3, No. 3, 1952, pp. 107–118. 25 references. (Presented before Society of Photographic Engineers, Naval Ordnance Laboratory, White Oak, Md., June 6, 1952.)

Aerial Prospecting for Radio Active Materials. E. A. Godby, S. H. G. Connock, J. F. Steljes, G. Cowper, and H. Carmichael. *Canada, National Research Council, Laboratories, Divisions of Mechanical Engineering and Atomic Energy, Joint Report Nos. MR-17, CRR-495*, March 13, 1952. 88 pp., illus. 10 references.

An Application of the Libessart Spark Gap to Photomicrography. E. L. Gayhart. *Photographic Engineering*, Vol. 3, No. 3, 1952, pp. 129–134, illus. 3 references. (Presented at 2nd Annual Symposium, Society of Photographic Engineers, Naval Ordnance Laboratory, White Oak, Md., June 4–6, 1952.)

An Introduction to Spark Shadowgraph Techniques. Rochelle Prescott. *Photographic Engineering*, Vol. 3, No. 3, 1952, pp. 121–128, illus. 8 references. (Presented at 2nd Annual Symposium, Society of Photographic Engineers, Naval Ordnance Laboratory, White Oak, Md., June 4–6, 1952.) To study high-speed phenomena; applications.

Chronophotography of a Reproducible Phenomenon. R. B. Edmondson, E. L. Gayhart, and H. L. Olsen. *Photographic Engineering*, Vol. 3, No. 3, 1952, pp. 135–144, illus. 6 references. (Presented at 2nd Annual Symposium, Society of Photographic Engineers, Naval Ordnance Laboratory, White Oak, Md., June 4–6, 1952.) Application of electronic time-delay methods to a schlieren study of dynamic behavior of gases affected by passage of an electric spark; techniques and instrumentations.

Current Problems in Guided Missile Instrumentation. H. M. Cobb. *Photographic Engineering*, Vol. 3, No. 3, 1952, pp. 119, 120. 1 reference.

Origins of Photographic Instrumentation. Frank Smith. *Photographic Engineering*, Vol. 3, No. 3, 1952, pp. 145–160, illus. 39 references. (Presented before Society of Photographic Engineers, Naval Ordnance Laboratory, White Oak, Md., June 6, 1952.)

Power Plants

Some Phenomena of Engine Wear as Revealed by Radioactive Tracer Technique. H. R. Jackson, F. C. Burk, L. J. Test, and A. T. Cowell. *SAE Quarterly Transactions*, Vol. 6, No. 3, July, 1952, pp. 518–524; Discussion, pp. 524–530, illus. 7 references. (Paper presented at S.A.E., National Fuels and Lubricants Meeting, Chicago, November 1, 1951.)

Liquid-Vapor Power Cycle. A. S. Thompson. *North American Aviation, Inc., Report No. NAA-SR-26*, February 3, 1949. 21 pp., illus., folded tables. Characteristics as a function of the cycle.

Power Plant Analysis. A. S. Thompson. *North American Aviation, Inc., Report No. NAA-SR-19*, October 26, 1948. 51 pp., illus. A general method for the preliminary thermodynamic analysis of a wide variety of power plants.

A Method for Comparing the Performance of Power Plants for Vertical Flight. H. S. Tsien. *American Rocket Society, Journal*, Vol. 22, No. 4, July-August, 1952, pp. 200–203, 212, illus. 11 references. Rocket and ram-jet engines compared.

The Turbojet, Ram-Jet and Rocket Air Force of the Future. Norman Macmillan. *Aeronautics*, Vol. 27, No. 1, August, 1952, pp. 24–31, illus. Comparison of the different types.

Power Packages—By the Thousand. Paul H. Wilkinson. *Aviation Age*, Vol. 18, No. 3, September, 1952, pp. 32, 33, illus. Rohr Aircraft Corp.'s complete engine nacelles.

Power Units; British Aero Engines in the SBAC Show. *Aeronautics*, Vol. 27, No. 2, September, 1952, pp. 73–80, illus.

Application of Titanium to Aircraft Engines. H. H. Hanink. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 755.* 14 pp., illus. Includes tables of cost and weight analysis and nominal compositions of components.

Efficient Filtration Spares Engine Wear. J. Parkinson. *Canadian Aviation*, Vol. 25, No. 8, August, 1952, pp. 24, 27, 28, 30, 46, 57, 58, illus. 2 references. Air, fuel, lubricating, and hydraulic filter designs.

Here's How to Hike Piston-Ring-Cylinder Life. Helmuth G. Braendel. *SAE Journal*, Vol. 60, No. 8, August, 1952, pp. 36–38, illus. (Based on a paper presented at S.A.E., Annual Meeting, Detroit, January 14, 1952.)

Principles and Application of Jet Power to Aircraft. I. B. Laskowitz. *American Helicopter*, Vol. 28, No. 11, October, 1952, pp. 6, 7, 13, illus. Comparisons of a generalized jet-engine and ram-jet, pulse-jet, turbojet, and turboprop designs.

Jet & Turbine

Simulation of Linearized Dynamics of Gas-Turbine Engines. J. R. Ketchum and R. T. Craig. *U.S., N.A.C.A., Technical Note No. 2826*, November, 1952. 25 pp., illus. 7 references.

The Pattern of Gas-Turbine Development in Europe and the United States. F. T. Hague. *Mechanical Engineering*, Vol. 74, No. 8, August, 1952, pp. 627–632, illus. 7 references.

Jupiter (T-400 Gas Turbine Engine) for Helicopters? Paul H. Wilkinson. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 40, 41, illus.

Effect of Aliphatic Halogen Compounds on Carbon Deposition from Aircraft Gas Turbine Fuels. W. Sacks and M. T. I. Ziebell. *Canada, National Aeronautical Establishment, Fuels and Lubricants Laboratory, Report LR-17*, January 2, 1952. 18 pp., illus. 14 references. (Also available as *Note No. 10*, 1952.)

Investigation of the Effect of the Length/Diameter Ratio of a Small-Scale Combustion Chamber on Weak Flame Stability Limits. F. G. Kitson. *Canada, National Aeronautical Establishment, Fuels and Lubricants Laboratory, Report No. LR-34*, August 7, 1952. 8 pp., illus. 8 references.

Examination of Smoke and Carbon From Turbojet-Engine Combustors. Thomas P. Clark. *U.S., N.A.C.A., Research Memorandum No. E52I26*, November 10, 1952. 12 pp., illus. 11 references.

The Cyclone Combustion Chamber and Gas Producer. H. A. Havemann. *Mechanical Engineer, Bangalore, India*, No. 2, December, 1951, pp. 19–25, illus. 7 references.

Torture Chambers for the J-47. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 15–18, 23, illus. Combustion chambers and transition liners produced by Ryan Aeronautical Co. for the G-E J-47.

A New Technique for Investigating Jet Engine Compressor Stall and Other Transient Characteristics. W. J. Kunz, Jr. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 770.* 17 pp., illus.

Split Compressors Usher in New Jet Era. Robert Hotz. *Aviation Week*, Vol. 57, No. 16, October 20, 1952, pp. 13–16, illus. Development and production status of twin-spool types.

"The Company We Keep"

THE EMERSON ELECTRIC MFG CO
8100 FLORISSANT AVENUE
ST. LOUIS 21, MO

GENERAL ELECTRIC COMPANY
APPARATUS SALES DIVISION

INDIANA GEAR WORKS
INCORPORATED

THE PIERCE GOVERNOR COMPANY, INC.

WESTINGHOUSE
ELECTRIC CORPORATION

A representative exhibit of a few of our customers who have long used Bardwell & McAlister, Inc. as a source of supply for

THE ROSÁN LOCKING SYSTEM

locking steel threaded inserts and studs in all materials softer than steel

ROSÁN Threaded Insert

ROSÁN Locked-in Studs

You are invited to join our "Good Company" — *write for our Rosán Catalog, Dept. 43.*

BARDWELL & McALISTER, Inc.
BURBANK, CALIFORNIA
The Original manufacturer of the Rosán Locking System

Over 85% of the torque wrenches used in industry are

STURTEVANT TORQUE WRENCHES

Read by Sight, Sound or Feel

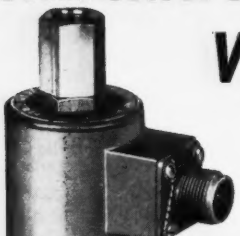
- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

in inch ounces
...inch pounds
...foot pounds
(All sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS

AIRCRAFT APPROVED



V5 Solenoid STAINLESS STEEL Valves

THREE-WAY NORMALLY OPEN AND NORMALLY CLOSED

WEIGHT ONLY 1¼ LBS. APPROX. 3½" HIGH

Soft synthetic rubber inserts in plunger prevent leakage...Spring loaded for positive action...Power consumption approx. 10 watts...Usable in any position...Operating pressure to 150 P.S.I....Fluid connections to suit your specifications.

Some models for aircraft, such as valve illustrated, have Yellow Dot approval. Other solenoid aircraft valves available and under development for pressures to 3,000 P.S.I.

Two-way normally open and normally closed solenoid valves for special media such as liquid oxygen, nitric acid and concentrated hydrogen peroxide are also available in a variety of sizes.

Inquiries regarding your solenoid valve problems are welcomed.

SKINNER ELECTRIC VALVES

Skinner ELECTRIC VALVE DIV.
THE SKINNER CHUCK COMPANY
104 Edgewood Ave., New Britain, Conn.

The **AERONAUTICAL ENGINEERING REVIEW** Announces its 3rd Annual **SPECIAL ISSUE** on **ELECTRONICS IN AVIATION**

May, 1953 Issue

INSTITUTE OF THE AERONAUTICAL SCIENCES

ORDER ADVERTISING SPACE NOW!
FORMS CLOSE APRIL 1ST

Write, Wire or Phone for detailed information and booklet, "Your Aviation Market."

Aeronautical Engineering Review
2 East 64th St., New York 21, N.Y.
TEmpleton 8-3800

Turbo Jet Power Control Trends. C. S. Constantino. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 820.* 7 pp., illus.

Turbojet Installation Cooling and Associated Performance Losses. Leonard J. Lyons. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 827.* 4 pp.

Continental-Turbomeca Small Gas Turbines. Whitney Collins. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 761.* 16 pp., illus.

A Supercharged Turbojet. *Aeronautics*, Vol. 27, No. 1, August, 1952, pp. 36, 37, illus. The Bristol Olympus.

C-46 Sports Small Turbojet Engine; Flying Tiger Line Experiments Prove Efficiency in 2-Engine Airfreighter. *Western Aviation*, Vol. 32, No. 11, November, 1952, p. 19, illus.

Turbo-Liner; Development of the Allison T-38 Engine in a Convair 240. *Flight*, Vol. 62, No. 2272, August 8, 1952, pp. 157–159, illus.

Canada Aviation Expands to Make Orenda. *Aviation Week*, Vol. 57, No. 16, October 20, 1952, pp. 40, 42, illus., cutaway drawing.

(Bristol Olympus) "Two-Spool" Turbojet. *Aviation Age*, Vol. 17, No. 2, August, 1952, p. 45, illus. General specifications.

Two Turbines Unveiled for Civil and Military Use. *Aircraft*, Vol. 30, No. 11, August, 1952, pp. 28–30, 48, illus., cutaway drawing. Bristol Proteus III and the Olympus engines.

Inside the Proteus (3). D. M. Desoutter. *Aeronautics*, Vol. 27, No. 2, September, 1952, pp. 83–87, illus., cutaway drawings.

The New (Bristol) Proteus (3) Turboprop. Paul H. Wilkinson. *Aviation Age*, Vol. 17, No. 2, August, 1952, pp. 40, 41, illus.

Progress Report on the Allison (501 or T38) Turboliner (Engine). D. J. Nolan. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 756.* 14 pp., illus. Experience data.

Characteristics of Expansion Turbines for Auxiliary Power. Homer J. Wood. *SAE Quarterly Transactions*, Vol. 6, No. 3, July, 1952, pp. 438–449, illus. 2 references. (Paper presented at S.A.E., Annual Meeting, Detroit, January 17, 1952.)

Turbine Engines Complicate Fuel System Design. C. Stewart Brandt. *SAE Journal*, Vol. 60, No. 8, August, 1952, pp. 50–52. (Excerpts from a paper presented at the S.A.E., National Aeronautic Meeting, Los Angeles, October 4, 1951.)

The Power Plant Installation as a Mutual Engine-Airframe Problem. William H. Hand. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 826.* 5 pp., illus.

Navy Development of Pneumatic Starting System for Gas Turbine Engines. A. K. Forney. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 813.* 12 pp., illus. 2 references.

Flight Testing of Prototype Engines as Primary Power Plants in New Airplanes. J. R. Steding. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 834.* 6 pp.

Ground Facilities—Altitude Test Chambers, Advantages and Limitations. D. M. Ross. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 831.* 4 pp.

It Takes a Jet to Test a Jet; A Paper on G-E's B-45 Flying Test Bed. Walter E. Stanger and Weldon R. Orme. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 833.* 10 pp., illus.

Afterburners and Variable Nozzles. Ralph Kress. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4,* 1952, Preprint No. 824. 13 pp., illus.

Jet Hot Rod. *Ryan Reporter*, Vol. 13, No. 5, August 1, 1952, pp. 2, 3, 19, 20, illus. Ryan XF2R-2 and other experience in producing afterburners; design aspects.

G-E's Jet Blade Tip Clearanceometer. A. W. Brunot and R. O. Fulton. *Aviation Age*, Vol. 18, No. 3, September, 1952, pp. 36, 37, illus.

Ram-Jet & Pulse-Jet

An Experimental Analysis of the Pulse Jet. D. G. Stewart. *Australia, Department of Supply, Aeronautical Research Laboratories, Report No. E. 70,* January, 1952. 53 pp., illus. 13 references.

Simplest Known Power Plant for Tomorrow's Fighter. William Green. *Aircraft*, Vol. 30, No. 11, August, 1952, pp. 20, 21, 42, illus. Leduc's continuous thermal duct research.

Reciprocating

Combustion-Chamber Deposition and Knock. H. J. Gibson, C. A. Hall, and D. A. Hirschler. *S.A.E., Fuels and Lubricants Meeting, Tulsa, Oklahoma, November 6–7, Preprint No. 851.* 17 pp., illus. 7 references.

Early Combustion Reaction in Engine Operation. E. B. Rifkin, C. Walcutt, and G. W. Betker, Jr. *SAE Quarterly Transactions*, Vol. 6, No. 3, July, 1952, pp. 472–487; Discussion, pp. 508–510, illus. 15 references. (Paper presented at S.A.E., National Fuels and Lubricants Meeting, Chicago, November 1, 1951.)

The Mode of Formation of Lead Deposits in Gasoline Engines. J. C. Street. *S.A.E., Fuels and Lubricants Meeting, Tulsa, Oklahoma, November 6–7, 1952, Preprint No. 859.* 22 pp., illus. 7 references.

NACA Investigation of Fuel Performance in Piston-Type Engines. Henry C. Barnett. *U.S., N.A.C.A., Report No. 1026,* 1951. 192 pp., illus. 13 references. Superintendent of Documents, Washington. $1.50.

Some Effects of Fuel Structure, Tetraethyl Lead, and Engine Deposits on Precombustion Reactions in a Firing Engine. Walter Cornelius and John D. Caplan. *SAE Quarterly Transactions*, Vol. 6, No. 3, July, 1952, pp. 488–508; Discussion, pp. 508–510, illus. 34 references. (Paper presented at S.A.E., National Fuels and Lubricants Meeting, Chicago, November 1, 1951.)

Some Factors Affecting Precombustion Reactions in Engines. M. W. Corzilius, D. R. Diggs, and D. L. Pastell. *S.A.E., Fuels and Lubricants Meeting, Tulsa, Oklahoma, November 6–7, 1952, Preprint No. 852.* 14 pp., illus. 6 references.

Engine Modification Improves Widgeon. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 72, 73, illus. Lycoming GO-435-C2 260-hp. engines in the Grumman G-44A.

Spark Ignition; Effect of Molecular Structure. H. F. Calcote, C. A. Gregory, Jr., C. M. Barnett, and Ruth B. Gilmer. *Industrial and Engineering Chemistry*, Vol. 44, No. 11, November, 1952, pp. 2656–2662, illus. 5 references.

Rocket

Thoughts on Rockets and Missiles. A. V. Cleaver. *Aircraft*, Vol. 30, No. 11, August, 1952, pp. 16–19, 46, illus., cutaway drawing. Survey of research, design specifications, and implications.

(Armstrong Siddeley) Snarler Boosts the Jets. *Aviation Age*, Vol. 18, No. 5, November, 1952, p. 44, illus.

Effect of Local Variations in Mixture Ratio on Rocket Performance. David Altman and Jack Lorell. *American Rocket Society, Journal*, Vol. 22, No. 5, September-October, 1952, pp. 252–255, illus. 2 references.

Isothermal Combustion Under Flow Conditions. Karl Scheller and James A. Bierlein. *American Rocket Society, Journal*, Vol. 22, No. 5, September-October, 1952, pp. 245–251, 287, illus. 3 references. (Presented at A.R.S., Annual Convention, Atlantic City, N.J., November 30, 1951.)

Longitudinal Vibrations of Gas at Ambient Pressure in a Rocket Thrust Chamber. I. Elias and Robert Gordon. *American Rocket Society, Journal*, Vol. 22, No. 5, September-October, 1952, pp. 263–268 illus. 8 references.

Servo-Stabilization of Combustion in Rocket Motors. H. S. Tsien. *American Rocket Society, Journal*, Vol. 22, No. 5, September-October, 1952, pp. 256–262, 268, illus. 8 references.

An Approximate Theory of Porous, Sweat, or Film Cooling With Reactive Fluids. L. Crocco. *American Rocket Society, Journal*, Vol. 22, No. 6, November-December, 1952, pp. 331–338, illus. 5 references. (Presented at A.R.S., Annual Meeting, Atlantic City, N.J., November 29, 1951.) Extension of Rannie's theory; development of a numerical application.

Rocket Power. *Aeronautics*, Vol. 27, No. 2, September, 1952, pp. 96, 97, illus. Operation of the Armstrong Siddeley Snarler.

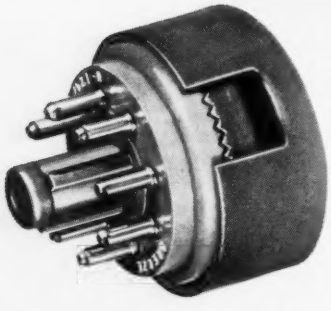
"Pinwheel" Power Package for Missiles; Auxiliary Unit's Design Saves Weight, Space.... William J. Coughlin. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, pp. 21, 22, 25, illus. Whirlojet, Inc.'s rotating rocket motor.

The Effect of Variable Propellant Density on Rocket Performance. H. S. Seifert. *American Rocket Society, Journal*, Vol. 22, No. 4, July-August, 1952, pp. 213–215, illus.

RUGGED as a RHINO... Quick as a Fox!

Two Special Purpose Connectors by

BREEZE MARK

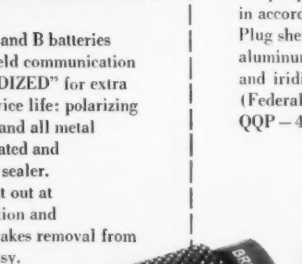


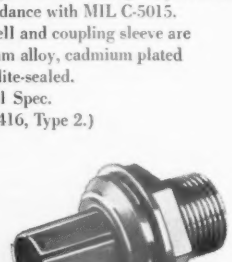
Battery Connectors

8-pin type for both A and B batteries used in all types of field communication equipment. "RUGGEDIZED" for extra security and long service life: polarizing stud is ALL METAL and all metal parts are cadmium plated and sealed with an iridite sealer. Cable may be brought out at any desired side position and locked. Handy bail makes removal from inaccessible places easy.

Quick Disconnect

Simply push male and female members together and lock. To disconnect with minimum resistance, pull back sleeve on plug shell and disconnect. Exceptionally low disengaging force required (less than 6 lbs., excepting pin friction). Vibration proof, moisture-proofed with synthetic rubber insert. Meets AN pin pattern and voltage requirements, in accordance with MIL C-5015. Plug shell and coupling sleeve are aluminum alloy, cadmium plated and iridite-sealed. (Federal Spec. QQP—416, Type 2.)





Receptacle Types: Round flange single hole panel-mounted, square flange for 4 bolts, or specially flanged to specification. All contacts silver plated.

We invite your inquiries on any problems concerning connectors. Our wealth of engineering experience in this specialty is at your service.

BREEZE CORPORATIONS, INC.

41 South Sixth Street, Newark, N. J.

Production

(Aircraft) Production Outlook in Western Europe. Randolph Hawthorne. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 6–18, 23–28, illus. Activities in Germany, Holland, Sweden, and England.

Britain Gets Set to Produce Its Aces. David A. Anderton. *Aviation Week*, Vol. 57, No. 17, October 27, 1952, pp. 20–22, 24, illus. Status of the Supermarine Swift and Hawker Hunter.

Chan-O-Seal for Modern Aircraft. Bernard Gross. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 819.* 6 pp., illus.

Millionths for Precision. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 69–71, illus. Methods and gage blocks and other equipment used at Ryan Aeronautical Company to check accuracy of parts measurements.

Problems Associated with the Manufacturing of Radomes. J. A. Sporcic and R. L. Whann. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 807.* 17 pp., illus. 4 references.

A Technique For Carving Honeycomb Material. M. Berry. *American Helicopter*, Vol. 28, No. 11, October, 1952, pp. 11, 12, 14, illus. Fabricating process developed by U.S. Propellers, Inc.

Three-Way Guide to British Aircraft. *Aeronautics*, Vol. 27, No. 2, September, 1952, pp. 52–81, illus. A directory of leading manufacturers.

Vickers' Variety. *Sperry Review*, Vol. 3, No. 5, Autumn, 1952, pp. 28–35, illus. 44-year experience of Vickers-Weybridge and Vickers-Supermarine in aircraft construction.

A Renovated Punch Press Department. *Aviation Age*, Vol. 17, No. 2, August, 1952, pp. 24–28, illus. Methods and equipment used at Douglas Aircraft Co.'s El Segundo Division.

Shipping Aircraft Spare Parts. *Aviation Age*, Vol. 17, No. 2, August, 1952, pp. 6–12, illus. Organizational and operational techniques of Douglas Aircraft Co.'s El Segundo Division.

In These Applications, Thick Polyester Parts Save Money . . . Reduce Weight. E. S. Goodridge. *Materials & Methods*, Vol. 36, No. 5, November, 1952, pp. 98, 99, illus. Induction Heating Corp.'s casting methods.

Balanced Production at Ryan. *Aviation Age*, Vol. 18, No. 3, September, 1952, pp. 16–18, 23, 24, illus. Fabrication methods for the exhaust system of the R-4360-59 Pratt & Whitney engine.

Salvage Control in Aircraft Production. Willis L. Nye. *Aero Digest*, Vol. 65, No. 3, September, 1952, pp. 106–112, illus.

Engineering Cost Analysis; A Systematic Approach to Lower Production Costs Through Better Design-Manufacturing Productibility Co-ordination. Richard H. Luders. *Machine Design*, Vol. 24, No. 7, July, 1952, pp. 145–149, illus.

Lockheed Uses "Ounce of Prevention". Irving Stone. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, pp. 30, 33, 34, 37, 38, illus. Equipment and methods of a functional test laboratory.

Product Quality Is Built-in. Dorian Shainin. *Aviation Age*, Vol. 18, No. 3, September, 1952, pp. 38–47, illus. 1 reference. Some statistical methods for aircraft quality control.

Quality Control: Job-Lot or Big Time. Dorian Shainin. *Aviation Age*, Vol. 17, No. 2, August, 1952, pp. 42, 43, illus. 1 reference. Problems; techniques.

AF Orders (Lockheed) C-130 Into Production. Alexander McSurely. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, pp. 13, 14, illus.

Completing the First R3Y (Turboprop) Flying Boat. *Automotive Industries*, Vol. 107, No. 9, November 1, 1952, p. 88, illus.

How Convair Puts Navy R3Y-1 Together. *Aviation Week*, Vol. 57, No. 15, October 13, 1952, pp. 41, 42, illus.

Suppliers Reveal: Major Defense Designs Begin to Reach Production Lines. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 186–188, illus. The Air Force's F-94C Starfire.

Metalworking

Brazing Hydromechanics. E. R. Funk and H. Udin. (*Welding Journal*, Vol. 31, No. 6, June, 1952, pp. 310s–316s.) *Engineers' Digest*, Vol. 13, No. 10, October, 1952, pp. 360–362, illus.

Cost Reduction Through Cold Extrusion. *Machine Design*, Vol. 24, No. 7, July, 1952, pp. 150, 151, illus.

How to Fabricate 17 Percent Chromium Stainless Steel. Richard E. Paret. *Materials & Methods*, Vol. 36, No. 5, November, 1952, pp. 100–104, illus. Properties and applications of type 430.

Materials & Methods Manual No. 87: Carburizing of Steels. John L. Everhart. *Materials & Methods*, Vol. 36, No. 4, October, 1952, pp. 135–150, illus. Methods; heat treatment; properties and applications; causes of defects.

Materials Engineering File Facts No. 233: Forming, Polishing and Machining Magnesium. *Materials & Methods*, Vol. 36, No. 2, August, 1952, p. 133.

Metal Processing at M.I.T.; Specially Prepared Textbooks Facilitate Undergraduate Teaching of Metal Working, Casting, and Welding. Howard F. Taylor. *Technology Review*, Vol. 55, No. 2, December, 1952, pp. 97–100, 124, 126, illus.

Metals Processing Laboratory (at M.I.T.) *Technology, Review*, Vol. 55, No. 2, December, 1952, pp. 89–92, 120, 122, illus.

Tapering Aircraft Skin Is Simplified. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 55–59, illus. Method uses abrasive belts developed by Carborundum Company and Bell Aircraft Corp.

The Direct Costs of "Redux" Bonding in Aircraft. *Aero Research Technical Notes, Bulletin No. 118*, October, 1952, 3 pp., illus.

Flame-Plating Strengthens Critical Metal Tools. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 60–68, illus. Linde Air Products Co.'s method of coating metals with tungsten carbide and other powdered metals.

Fokker Tests Redux-Bonding. Randolph Hawthorne. *Aviation Age*, Vol. 18, No 5, November, 1952, pp. 36, 37, illus.

Metalbond Wing for (Lockheed) Super Connie. *Aviation Week*, Vol 57, No. 16, October 20, 1952, p. 43, illus.

Thin Ductile Carbide Coatings Possible with New Method (of Flame-Plating). F. E. King. *Materials & Methods*, Vol. 36, No. 4, October, 1952, pp. 112–114, illus.

What's New in Adhesives. Kenneth Rose. *Materials & Methods*, Vol. 36, No. 4, October, 1952, pp. 132–134, illus. Types; techniques of application.

A Continuous Aluminium Casting and Rolling Installation. *The Engineer*, Vol. 194, No. 5045, October 3, 1952, pp. 465, 466, illus.

Investment Casting Pays Off. *Aviation Age*, Vol. 17, No. 2, August, 1952, pp. 30–32, illus. Methods and equipment used at Pacific Consolidated Industries.

Materials & Methods Manual No. 86: Carbon and Low Alloy Steel Castings. Philip O'Keefe. *Materials & Methods*, Vol. 36, No. 3, September, 1952, pp. 119–134, illus. 3 references. Properties; specifications; design; joining; heat treating; inspection.

Forging Technique. E. W. Peel. *Society of Licensed Aircraft Engineers, Journal* (*The Technical Instructor* section), Vol. 1, No. 10, October, 1952, pp. 16–18, 22, illus. High-strength wrought aluminum alloys problems.

High Strength Aluminum Impact Extrusion. M. P. Meinel. *Materials & Methods*, Vol. 36, No. 5, November, 1952, pp. 110–113, illus.

Huge Forging Press for Producing Aluminum, Magnesium Aircraft Parts. *Automotive Industries*, Vol. 107, No. 9, November 1, 1952, p. 92, illus.

Materials & Methods Manual No. 84: Cold Forming Stainless Steel Parts. Kenneth Rose. *Materials & Methods*, Vol. 36, No. 1, July, 1952, pp. 101–116, illus. Methods and selection factors; annealing procedures.

Materials Engineering File Facts No. 238: Bending of Aluminum Alloy Sheet. *Materials & Methods*, Vol. 36, No. 5, November, 1952, p. 143.

Preforming Gives Better Metal Contours. John Engel. *Aviation Age*, Vol. 18, No. 4, October, 1952, pp. 50–55, illus. The Engel-Preform method.

Wanted: A Single-Piece Wing Grid. Gil Close. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 74–79, illus. North American Aviation Co.'s die quenching process to produce massive structural components.

How to Heat Treat Aluminum. Floyd A. Lewis. *Materials & Methods*, Vol. 36, No. 3, September, 1952, pp. 99–103, illus.

Induction Hardening Boron Steel Gears. George Van Camp. *Materials & Methods*, Vol. 36, No. 5, November, 1952, pp. 121, 122, illus.

One Way to Increase Heat Treating Furnace Efficiency. Frank Panlener. *Materials & Methods*, Vol. 36, No. 2, August, 1952, pp. 106, 107, illus. Redesigning of equipment.

Carbide Developments. J. S. Gillespie and I. L. Wallace. *Machine Design*, Vol. 24, No. 9, September, 1952, pp. 266, 268, 270. (Based on a paper presented at the 16th Annual Machine Tool Electrification Forum, Pittsburgh, April, 1952.) Seven basic factors; application in jet-engine production.

Draftless Wrought Parts Spell Higher Production; McDonnell Cuts Down on Machining. Charles F. Marschner. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 46–53, illus. 5 references.

Electromechanical Machining. Malcolm F. Judkins. *Machine Design*, Vol. 24, No. 7, July, 1952, pp. 230, 232, 234, 236. (Based on a paper presented at the 20th Annual Meeting, American Society of Tool Engineers, Chicago, March, 1952.) Accuracy; production rates.

Hot Machining Methods for Difficult-to-Machine Metals. A. A. Caminada. *Materials & Methods*, Vol. 36, No. 1, July, 1952, pp. 98–100, illus. 12 references. Hot versus cold techniques.

Electronics in Resistance Welding. P. Huggins. *Electronic Engineering, Electronics in Industry Supplement*, Vol. 24, No. 297, pp. 526–529, illus. 13 references.

Materials & Methods Manual No. 88: Welded and Brazed Parts. H. R. Clauser. *Materials & Methods*, Vol. 36, No. 5, November, 1952, pp. 123–138, illus. 3 references. Specifications for welding; weldable materials; characteristics and design of welded joints; cost analysis; typical applications.

Materials Engineering File Facts No. 232: Preheat Temperatures for Welding Metals and Alloys. *Materials & Methods*, Vol. 36, No. 2, August, 1952, p. 131.

Selecting the Correct Welding Process. John J. Chyle. *Machine Design*, Vol. 24, No. 8, August, 1952, pp. 182–185, 265, 266, 268, illus. (Based on a paper presented at the S.A.E., Summer Meeting, Atlantic City, N. J., June, 1952.) Recommended processes for different materials.

Welding in the Soviet Union. J. Mannin. *Engineer's Digest*, Vol. 13, No. 10, October, 1952, pp. 351–354.

Tooling

International Machine Tool Exhibition—London, 1952. I, II. *Engineer's Digest*, Vol. 13, Nos. 8, 9, August, September, 1952, pp. 269–274; 319–323, 318, illus. New designs and applications.

The International Machine Tool Exhibition at Olympia. I, II, III. *The Engineer*, Vol. 194, Nos. 5044, 5045, 5046, September 26, October 3, 10, 1952, pp. 402–409; 438–443; 474–477, illus. Descriptions of various new tooling devices and development.

Second European Machine Tool Exhibition, Hanover. I, II, III. *The Engineer*, Vol. 194, Nos. 5047, 5048, 5049, October 17, 24, 31, 1952, pp. 511, 512; 542–545; 586–588, illus.

2nd European Machine Tool Exhibition—Hanover, 1952. I, II. *Engineers' Digest*, Vol. 13, Nos. 8, 9, August, September, 1952, pp. 275—278; 324–328, illus. Examples of new developments.

Alloyed-Titanium Tooling. James Joseph. *Aero Digest*, Vol. 65, No. 2, August, 1952, pp. 17–19, illus. Major problems.

An Analysis of Feed Mechanisms in Machine Tools Regarding Uniformity of Advance and Sensitivity of Adjustment. M. E. Elyasberg. (*Stanki i Instrument, Nos. 11, 12*, 1951, pp. 1–7; 6–9.) *Engineers' Digest*, Vol. 13, Nos. 9, 10, September, October, 1952, pp. 298–300; 338–340, illus.

Big Casting Arrives for Big Press. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, p. 42, illus. Alcoa's 13,200-ton extruder.

Direct-Acting (Wheelon) Hydropress. *Mechanical Engineering*, Vol. 74, No. 8, August, 1952, pp. 658, 659, illus.

Hi-Jet System for Increasing Tool Life. R. J. S. Pigott and A. T. Colwell. *SAE Quarterly Transactions*, Vol. 6, No. 3, July, 1952, pp. 547–564; Discussion pp. 564–566, illus. 2 references. (Paper presented at S.A.E., Annual Meeting, Detroit, January 15, 1952.)

How Plastics Cut F-84 Costs. Ben Sokol. *Aero Digest*, Vol. 65, No. 3, September, 1952, pp. 102–105, illus.

Hydraulic Bag Pressurizes Press Pad. *Machine Design*, Vol. 24, No. 7, July, 1952, p. 142, illus. Douglas Aircraft Co.'s Wheelon Press.

Latest Developments in High Speed Automatic Molding Machinery. Fred C. Means. *Society of Plastics Engineers, Journal*, Vol. 8, No. 9, November, 1952, pp. 14–16, illus.

Machine Tools for Fine Machining. P. Grodzinski. *Engineers' Digest*, Vol. 13, No. 8, August, 1952, pp. 238–244, illus. 8 references.

Modern Machine Tool Manufacturing Methods. T. P. N. Burness. *Engineers' Digest*, Vol. 13, No. 9, September, 1952, pp. 293–295, 306.

New Horizons for Machine Tools; New Techniques of Instrumentation and Analysis Stimulate Teaching and Research in the Field of Metal Cutting. Prescott A. Smith. *Technology Review*, Vol. 55, No. 2, December, 1952, pp. 93–96, 130, illus.

Press Hydroforms Deep Parts. *Machine Design*, Vol. 24, No. 7, July, 1952, p. 140, illus. Cincinnati Milling Machine Co.'s new metal-forming machine.

Smaller Presses For Bigger Jobs. *Aviation Age*, Vol. 18, No. 3, September, 1952, pp. 59–63, illus. Design and applications of the Wheelon direct-acting hydraulic press.

Soviet Machine Tools. I, II, III. J. Mannin. *Engineers' Digest*, Vol. 13, Nos. 8, 9, 10, August, September, October, 1952, pp. 253–256; 309, 310, 316; 351–354. Recent advances and developments.

Special Purpose Machine Tools and the Unit Construction Principle. J. C. Z. Martin. *Engineers' Digest*, Vol. 13, No. 9, September, 1952, pp. 301–306, illus. 8 references. Development during and since World War II.

Stretch-Flattening Machine. *Mechanical Engineering*, Vol. 74, No. 8, August, 1952, p. 663, illus. Developed by Longren Aircraft Company for processing in volume aluminum-alloy integrally stiffened extruded skin sections.

Welded Machine Tools. O. Bondy, *Engineers' Digest*, Vol. 13, No. 8, August, 1952, pp. 263–266, illus. 14 references. Types; design considerations.

Propellers

Overall Thrust, Thrust Grading, and Torque Measurements on a Two-blade, 6 1/2 per cent thick, NACA 16 Section Propeller in the High-Speed Tunnel. G. S. Hislop, G. F. Hughes, and D. S. Capps. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2515*, 1951 (July, 1947). 45 pp., illus. 11 references. British Information Services, New York. $2.60.

de Havilland Propellers for the Britannia and the Princess. *De Havilland Gazette*, No. 71, October, 1952, pp. 148–150, illus.

Grinder Chucks Propeller Blades Vertically. *Machine Design*, Vol. 24, No. 7, July, 1952, pp. 138, 139, illus.

Reference Works

Chemical Engineering Materials of Construction (Sixth Annual Review). *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2285–2380, illus. 2038 references.

Current Literature on Aviation. *Journal of Air Law and Commerce*, Vol. 19, No. 2, Spring, 1952, pp. 249–251. 43 references. Includes books, pamphlets, and domestic and foreign periodical articles.

Helium: Bibliography of Technical and Scientific Literature From Its Discovery (1868) to January 1, 1947. Henry P. Wheeler, Jr., and Louise B. Swenarton. *U.S., Department of the Interior, Bureau of Mines, Bulletin No. 484*, 1952. 76 pp. 2616 references. Superintendent of Documents, Washington. $0.35. Breakdown by characteristics, chemistry, production, and utilization; author index.

Directory of Suppliers of Industrial Coatings, Equipment and Supplies. *Organic Finishing*, Vol. 13, No. 9, September, 1952, pp. 32–54.

Three-Way Guide to British Aircraft. *Aeronautics*, Vol. 27, No. 2, September, 1952, pp. 52–81, illus. A directory of leading manufacturers.

Rotating Wing Aircraft

British Helicopter Developments. A. McClements. *Helicopter Association of Great Britain, Journal*, Vol. 6, No. 2, August-October, 1952, pp. 49–70, illus. 52 references. 1926–1952 period.

Jupiter (T-400 Gas Turbine Engine) for Helicopters? Paul H. Wilkinson. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 40, 41, illus.

A Review of Helicopter Patents. L. H. Hayward. *Helicopter Association of Great Britain, Supplement to Journal*, Vol. 5, No. 4, 1952. 14 pp., illus.

Some Recent Helicopter Research Investigations. Wm. Stewart. *Helicopter Association of Great Britain, Journal*, Vol. 6, No. 1, April–July, 1952, pp. 3–12; Discussion, pp. 13–20, illus. Operation and performance, stability and control, design, and other aerodynamic aspects.

American Helicopter Co.'s XH-26 Pulse-Jet-Powered Single-Place Collapsible Helicopter. M. Berry. *American Helicopter*, Vol. 28, No. 10, September, 1952, pp. 8, 15, illus.

American Helicopter Co.'s XH-26 Pulse-Jet-Powered Single-Place Collapsible Helicopter. *Aviation Week*, Vol. 57, No. 15, October 13, 1952, pp. 21–23, 25, 26, 28, illus.

Fairey Rotodyne Twin-Engined Turbojet Helicopter, England. *Aviation Week*, Vol. 57, No. 14, October 6, 1952, p. 17, illus.

Kaman Model HTK-1 Three-Place Counter-Rotating Twin-Rotor Helicopter. Randolph Hawthorne. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 42, 43, illus.

S.N.C.A.S.E. SE-3120 General Utility Three-Place Helicopter, France. C. Colin Cooper. *American Helicopter*, Vol. 28, No. 10, September, 1952, pp. 9–12, illus.

Sikorsky S-55 10-12 Place Helicopter. *Aviation Week*, Vol. 57, No. 16, October 20, 1952, pp. 49–51, 55, 56, 58, illus. Results of Los Angeles Airways' proving run.

Smolensk Motorless Single-Rotor Trainer Helicopter-Glider, U.S.S.R. *Sailplane and Glider*, Vol. 20, No. 9, September, 1952, p. 19.

Design For a Jet-Powered Helicopter. G. F. Champlin. *American Helicopter*, Vol. 27, No. 8, July, 1952, pp. 6–8, 14, illus.

'Copter Autopilot. L. E. Sheehan and L. J. Vetter. *Flight Lines*, Vol. 3, No. 6, November, 1952, pp. 10–12, illus. Specialized design and equipment.

The Determination in Flight of the Body Drag and the Mean Blade Profile Drag Coefficient of a Helicopter. F. E. Bartholomew and W. S. D. Marshall. *College of Aeronautics, Cranfield, England, Report No. 56*, April, 1952. 16 pp., illus. 10 references.

Helicopter Operating Experiences. A. V. J. Vernieuwe. *Helicopter Association of Great Britain, Journal*. Vol. 6, No. 2, August-October, 1952, pp. 31–41; Discussion, 41–48, illus. (Lecture presented at the Institution of Civil Engineers, London, September 5, 1952.)

The Application of Jet Propulsion to Helicopters. Wm. Stewart and M. F. Burle. *Gt. Brit., Aeronautical Research Council, Current Papers No. 8*, 1950. 24 pp., illus. 7 references. British Information Services, New York. $0.40.

Blade Feathering and Feathering Hinges. I, II. Paul Baumgartl. *American Helicopter*, Vol. 27, Nos. 8, 9, July, August, 1952, pp. 10, 11, 14, 15; 12–14, 16, 17, illus. Includes jet-powered and large-sized types.

Notes on Helicopter Rotor Behavior after Engine Failure in Hovering Flight. W. Stewart and G. J. Sissingh. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2659*, 1952 (May, 1949). 6 pp., illus. 2 references. British Information Services, New York. $0.50.

Strain Measurements of Rotor Blades. M. Berry. *American Helicopter*, Vol. 27, No. 8, July, 1952, pp. 9, 15, 16, illus.

Big Future Forecast for Intercity Copters. *Aviation Week*, Vol. 57, No. 15, October 13, 1952, pp. 91, 92, illus.

Britain's Helicopters for the Army. R. H. Bower. *American Helicopter*, Vol. 28, No. 10, September, 1952, pp. 13–16, illus.

WIDE RANGE BRIDGE OSCILLATOR

5 *Kc to* 50 *Mc and 3 Fixed Audio Frequencies*

Specifications

WIDE FREQUENCY RANGE: *continuously adjustable from 5 kc to 50 Mc; fixed audio frequencies of 60, 400 and 1000 cycles*

RAPID FREQUENCY SELECTION: *r-f tuning dial and range switch permit rapid and accurate selection of desired frequency*

INCREMENTAL FREQUENCY DIAL: *slow-motion dial on tuning control indicates 0.1% frequency increments of main dial*

GOOD ACCURACY: *± 2% for carrier frequencies above 150 kc; 3% below 150 kc; ±5% at 400 and 1000 cycles*

INTERNAL MODULATION: *both 400 and 1000 cycle at 30% or 60% levels provided*

GOOD OUTPUT: *r.f. is 10 volts, open circuit; 1 watt into matching 50-ohm load — audio is 12 volts, open circuit, ¾ watt into matching 50-ohm load*

LOW DISTORTION: *r-f, 3% over most of range; a-f approximately 5% at 400 cycles and at 1 kc; envelope distortion less than 6% at 60% modulation, 3% at 30% level*

LOW LEAKAGE: *r-f and audio circuits are in shielded compartment in main cabinet. Leads to plate and heater are filtered. At 1 Mc stray fields are about 50 microvolts per meter at two feet from instrument*

Type 1330-A Bridge Oscillator $525.00

The General Radio Type 1330-A Bridge Oscillator is finding wide application as a variable-frequency power source for bridge and other measurements at radio and audio frequencies. Its wide range of 5 kc to 50 Mc, with spot frequencies at 60, 400 and 1000 cycles make it a particularly flexible instrument.

Internal modulation at 400 and 1000 cycles at 30% or 60% modulation is supplied.

Its good shielding, adequate output for most r-f measurements and excellent frequency stability with low distortion make this a most versatile general-purpose oscillator.

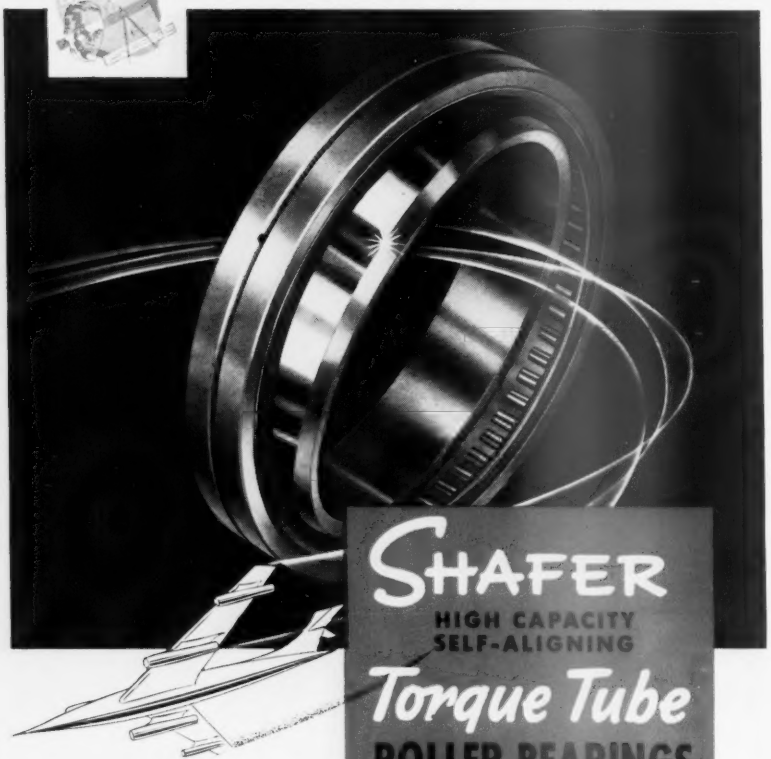
GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

90 West St. NEW YORK 6 920 S. Michigan Ave. CHICAGO 5 1000 N. Seward St. LOS ANGELES 38

Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors
Decade Inductors ☆ Decade Resistors ☆ Distortion Meters
Frequency Meters ☆ Frequency Standards ☆ Geiger Counters
Impedance Bridges ☆ Modulation Meters ☆ Oscillators
Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls
Noise Meters ☆ Null Detectors ☆ Precision Capacitors
Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters
U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes

Another Example of Shafer Design Leadership



SHAFER
HIGH CAPACITY
SELF-ALIGNING
Torque Tube
ROLLER BEARINGS

The pioneering and mass production of advanced types of aircraft roller bearings is a basic part of Shafer's business. Here, for example, is a recent addition to the expanding parade of Shafer "firsts"—a self-aligning, torque tube type, double row, roller bearing that provides full freedom of rotation and proper alignment whenever structural deflections occur during flight. It is factory-lubricated and equipped with positive seals which retain the lubricant and also provide efficient sealing against pressurization. Like ALL Shafer Aircraft Control Bearings it conforms to all military and commercial specifications—combines compactness, light weight and top quality with unsurpassed ruggedness of construction, dependability of performance and utmost resistance to shock loads. Write for details—and remember . . .

Shafer's all-important asset—33 years of specialized roller bearing experience—is yours to draw from without cost or obligation at any and all times.

SHAFER BEARING CORPORATION
801 Burlington Ave • Downers Grove, Illinois

Check These Proven Features

✓ **SIMPLE, COMPACT DESIGN** eliminates parts and facilitates installation.

✓ **HIGH ROLLER BEARING CAPACITY** with minimum cross-section and weight.

✓ **COMPENSATES FOR MISALIGNMENT** resulting from mounting inaccuracies and deflections of operating structural members.

✓ **SELF-ALIGNING** action within the rolling elements insures freedom of rotation and proper alignment under all conditions.

✓ **POSITIVE SEALS** retain lubricant and provide efficient sealing against pressurization.

✓ **LUBRICANT GROOVE** in outer race simplifies relubrication.

SHAFER

. . . Specialists in Aircraft and Industrial Self-Aligning Roller Bearings for over ⅓ of a century.

High-Altitude Helicopter Operations. Hugh Harvey. *American Helicopter*, Vol. 28, No. 11, October, 1952, pp. 9, 10. Okanagan Air Services, Ltd.'s pioneering work.

Sciences, General

Mathematics

On Approximate Solutions of Systems of Linear Inequalities. Alan J. Hoffman, *U.S., National Bureau of Standards, Journal of Research*, Vol. 49, No. 4, October, 1952, pp. 263–265. 2 references. (Also available as *Research Paper 2362*. Superintendent of Documents, Washington. $0.05.)

Generalization of Boundary-Layer Momentum-Integral Equations to Three-Dimensional Flows Including Those of Rotating System. Arthur Mager. (*U.S., N.A.C.A., Technical Note No. 2310*, 1951.) *U.S., N.A.C.A., Report No. 1067*, 1952. 16 pp., illus. 18 references. Superintendent of Documents, Washington. $0.20.

Integrals and Integral Equations in Linearized Wing Theory. Harvard Lomax, Max A. Heaslet, and Franklyn B. Fuller. (*U.S., N.A.C.A., Technical Note No. 2252*, 1950.) *U.S., N.A.C.A., Report No. 1054*, 1951. 34 pp., illus. 18 references. Superintendent of Documents, Washington. $0.30.

The Numerical Method of Characteristics for Hyperbolic Problems in Three Independent Variables. C. K. Thornhill. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2615*, 1952 (September, 1948). 13 pp., illus. 2 references. British Information Services, New York. $0.90.

On the Momentum Equation in Laminar Boundary-Layer Flow: A New Method of Uniparametric Calculation. B. Thwaites. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2587*, 1952 (December, 1947). 9 pp. 9 references. British Information Services, New York. $0.75.

Pointwise Bounds for the Solutions of Certain Boundary-Value Problems. J. L. Synge. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1093, August 22, 1951, pp. 170–175. 7 references. For Dirichlet-Neumann types.

Singular Integral Equations; Boundary Problems of Function Theory and Their Application to Mathematical Physics. N. I. Muskhelishvili. (Institute of Mathematics, Tiflis, U.S.S.R., 1946. Translated by J. R. M. Radok and W. G. Woolnough.) *Australia, Department of Supply and Development, Aeronautical Research Laboratories, Translation No. 12*, February, 1949. 404 pp. 115 references.

Upper and Lower Bounds for the Numerical Solution of the Dirichlet Difference Boundary Value Problem. J. B. Diaz and R. C. Roberts. *Journal of Mathematics and Physics*, Vol. 31, No. 3, October 1952, pp. 184–191. 7 references.

A New Method of Solving the Born-Green Equation for the Radial Distribution Function. A. G. McLellan. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol.

210, No. 1103, January 22, 1952, pp. 509–517, illus. 12 references.

The Relation of Eddington's E-Numbers to the Tensor Calculus. I—The Matrix Form of E-Numbers. II—An Extension of Tensor Transformation Theory. S. R. Milner. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1118, September 23, 1952, pp. 292–329. 3 references.

Some Theorems on Perturbation Theory. IV. E. C. Titchmarsh. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1100, December 7, 1951, pp. 30–47. 3 references.

The Zeros of $P'_{n_3}(x_n)$ of Non-Integral Degree. K. M. Siegel, J. W. Crispin, R. E. Kleinman, and H. E. Hunter. *Journal of Mathematics and Physics*, Vol. 31, No. 3, October, 1952, pp. 170–179. 13 references. Method devised for use at the University of Michigan Willow Run Research Center.

An Analysis of the Errors in Curve-Fitting Problems with an Application to the Calculation of Stability Parameters from Flight Data. Marvin Shinbrot. *U.S., N.A.C.A., Technical Note No. 2820*, November, 1952. 29 pp., illus. 3 references.

An Approximation Connected with Cos *n* and Sin *n*. J. Berghuis. *Netherlands, Mathematisch Centrum, Amsterdam, Report No. R 72*, 1951. 9 pp. 4 references.

Asymptotic Expansions Connected with Truncated Series of Exponential and Bessel Type. J. A. Zonneveld and J. Berghuis. *Netherlands, Mathematisch Centrum, Amsterdam, Report No. MR 8*, 1952. 13 pp., illus. 14 references.

On a Certain Asymptotic Expansion. A. van Wijngaarden. *Netherlands, Mathematisch Centrum, Amsterdam, Report No. R 177*, 1952. 3 pp.

On a Certain Type of Integral Associated with Circular Cylinders. J. M. Hammersley. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1100, December 7, 1951, pp. 98–110. 10 references.

Decimal-Binary Conversion and Deconversion. A. van Wijngaarden. *Netherlands, Mathematisch Centrum, Amsterdam, Report No. R 130*, 1951. 41 pp.

Derivation and Application of a General Formula for Directly Computing the Skin Thickness of Wings and Tailplanes. A. H. Hall. (*Canada, National Research Council, Division of Mechanical Engineering, Report No. MM-221*, April, 1950.) *Canada, National Aeronautical Establishment, Report No. R 12*, 1951. 24 pp., illus. 4 references.

Empirical Equations for Three-Variable Data. Harry Stern. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2442–2444, illus. 3 references.

The Enumeration of Graphs in the Feynmann-Dyson Technique. C. A. Hurst. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1116, August 7, 1952, pp. 44–61, illus. 6 references.

Formulas for Numerical Differentiation in the Complex Plane. Herbert E. Salzer. *Journal of Mathematics and Physics*, Vol. 31, No. 3, October, 1952, pp. 155–169.

Lagranian Integration Coefficients for Distance Functions Taken Over Right Circular Cylinders. J. M. Hammersley. *Journal of Mathematics and Physics*, Vol. 31, No. 2, July, 1952, pp. 139–150. 5 references.

The Minimum of a Non-Homogeneous Binary Cubic Form. J. H. H. Chalk. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 392–401. 8 references.

The Resolution of Complex Quantities. N. H. Crowhurst. *Electronic Engineering*, Vol. 24, No. 295, September, 1952, pp. 426–428, illus. 3 references. Charts for assisting calculations.

Solution of the Cubic Equation by a Simplified Procedure. Ennis E. Jones. *Product Engineering*, Vol. 23, No. 9, September, 1952, pp. 183–189.

A Solution of the Telegraph Equation with Application to Two Dimensional Supersonic Shear Flow. Chieh-Chien Chang and Jack Werner. *Journal of Mathematics and Physics*, Vol. 31, No. 2, July, 1952, pp. 91–101, illus. 6 references.

Transformations Depending on Sets of Associated Points. T. G. Room. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 383–391. 3 references.

Truncated Power-Series. J. Berghuis. *Netherlands, Mathematisch Centrum, Amsterdam, Report No. R 173*, 1952. 11 pp. 9 references.

Table of the Integral $\int_0^1 \exp(-v^{-2}-xv)v^{-p}dv$. A. van Wijngaarden. *Netherlands, Mathematisch Centrum, Amsterdam, Report No. R 176*, 1952. 6 pp.

Tables for Numerical Integration at Non-Equidistant Argument Steps. H. O. Hartley. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 436–442. 5 references.

Tables for Use in Rank Correlation. L. Kaarsemaker and A. van Wijngaarden. *Netherlands, Mathematisch Centrum, Amsterdam, Report No. R 73*, 1952. 17 pp.

On the Choice of Standard Solutions to Weber's Equation. J. C. P. Miller. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 428–435, illus. 5 references.

On an Extension of Riemann's Method of Integration, with Applications to One-Dimensional Gas Dynamics. Geoffrey S. S. Ludford. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 499–510, illus. 6 references. Development of an unfolding procedure in partial differential equations of hyperbolic type.

On the Transformation of Certain Integral Equations to Differential Equations. J. P. O. Silberstein. *Australia, Department of Supply, Aeronautical Research Laboratories, Report No. SM. 176*, September, 1951. 32 pp. 1 reference.

Separability in a Class of Coordinate Systems. Parry Moon and Domina Eberle Spencer. *Franklin Institute, Journal*, Vol. 254, No. 3, September, 1952, pp. 227–242. 4 references. Study of separability conditions for the Helmholtz and Laplace equations.

Two-Phase Equilibrium in Binary and Ternary Systems. IX—Derivation of the General Equation Defining a Small Change at Equilibrium. R. F. Strickland-Constable. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1116, August 7, 1952, pp. 36–43. 5 references.

Congruence Properties of the Partition Function and Associated Functions. J. M. Rushforth. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 402–413. 23 references.

Differentiation of Some Classes of Set Functions. Charles A. Hayes. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 374–382. 3 references.

A Note on Entire Functions Used in Analytic Interpolation. J. Berghuis. *Netherlands, Mathematisch Centrum, Amsterdam, Report No. R. 143, II*, 1952. 4 pp.

Relations Between Delta Functions. B. Gross and H. Pelzer. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1102, January 7, 1952, pp. 434–437, illus. 4 references.

An Associated Bessel Function. Yudell L. Luke. *Journal of Mathematics and Physics*, Vol. 31, No. 2, July, 1952, pp. 131–138. 10 references.

Some New Asymptotic Expansions for Bessel Functions of Large Orders. F. W. J. Olver. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 414–427, illus. 8 references.

Supplementary Tables for Special Functions Used in the Calculation of Airloads on Oscillating Wings (Special Functions of NACA TN 1195). R. J. Crookshanks. *Douglas Aircraft Company, Inc., Report No. SM-14200*, November 27, 1951. 18 pp. 4 references.

Tables of Multhopp and other Functions for Use in Lifting-Line and Lifting-Plane Theory. V. M. Falkner and E. J. Watson. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2593*, 1952 (February, 1948). 52 pp., illus. 3 references. British Information Services, New York. $3.15.

Transforms for the Eddy-Diffusion of Clusters. L. F. Richardson. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1116, August 7, 1952, pp. 1–20, illus. 20 references.

Investigation of Statistical Nature of Fatigue Properties. E. Epremian and R. F. Mehl. *U.S., N.A.C.A., Technical Note No. 2719*, June, 1952, 119 pp., illus. 50 references. Survey of all aspects of the subject and review of the literature; statistical modes.

A Note on the Sequential Estimation of Means. D. R. Cox. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 447–450. 6 references. Method of finding a nearly unbiased estimate.

Notes on a Theorem of Cochran. G. S. James. *Cambridge Philosophical Society Proceedings*, Vol. 48, Part 3, July, 1952, pp. 443–446. 7 references.

On the Application of Statistical Concepts to the Buffeting Problem. H. W.

Liepmann. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 793–800, 822, illus. 14 references.

Order-Disorder Statistics. IV—A Two-Dimensional Model with First and Second Interactions. C. Domb and R. B. Potts. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1100, December 7, 1951, pp. 125–141, illus. 17 references.

Physics

The Commutation Laws of Relativistic Field Theory. R. E. Peierls. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1117, August 21, 1952, pp. 143–157. 7 references.

Comparison of the Acceleration Due to Gravity at the National Physical Laboratory, Teddington, the Bureau International des Poids et Mesures, Sèvres, the Physikalisch-Technische Bundesanstalt, Brunswick, and the Geodetic Institute, Potsdam. A. H. Cook. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1114, July 8, 1952, pp. 408–424. 19 references.

The General Static Spherically Symmetric Solution in Einstein's Unified Field Theory. W. B. Bonnor. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1102, January 7, 1952, pp. 427–434. 5 references.

Laws of Attraction Having a Certain Generalized Newtonian Property. H. D. Block. *Journal of Mathematics and Physics*, Vol. 31, No. 2, July, 1952, pp. 151–153. 3 references.

Electronic Bound States at the Surface of a Metal. G. R. Baldock. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 457–469, illus. 14 references.

Quantum Field Theory of Bound States. I—Bound States in Weak Interaction. R. J. Eden. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 215, No. 1120, November 6, 1952, pp. 133–146, illus. 7 references.

Threshold Behaviour in Quantum Field Theory. R. J. Eden. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1102, January 7, 1952, pp. 388–404. 13 references.

A New Classical Theory of Electrons. II. P. A. M. Dirac. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 212, No. 1110, May 7, 1952, pp. 330–339. 3 references. Analysis of the motion of a stream of electrons obeying Lorentz's equation of motion; deduction of a Hamiltonian formulation of the equations.

The Diamagnetism of Free Electrons. E. H. Sondheimer and A. H. Wilson. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1101, December 20, 1951, pp. 173–190, illus. 24 references.

Electronic Levels in Simple Conjugated Systems. II—Butadiene. III—The Significance of Configuration Interaction. C. A. Coulson and Juliane Jacobs. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 206, No. 1086, May 7, 1951, pp. 287–296; 297–308, illus. 31 references.

On the Interaction of Two Electrons. G. E. Brown and D. G. Ravenhall. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1095, September 24, 1951, pp. 552–559. 9 references.

Electrical Breakdown of Gases. I—Spark Mechanism in Air. F. Llewellyn Jones and A. B. Parker. **II—Spark Mechanism in Nitrogen.** J. Dutton, S. C. Haydon, and F. Llewellyn Jones. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1113, June 24, 1952, pp. 185–214, illus. 22 references.

Secondary Processes Active in the Electrical Breakdown of Gases. Leonard B. Loeb. *British Journal of Applied Physics*, Vol. 3, No. 11, November, 1952, pp. 341–349. 49 references.

Electrical Contact Resistance between Metallic Surfaces Subjected to Various Treatments. T. Fukuroi and Y. Muto. (*Tôhoku University, Japan, Science Reports of the Research Institutes*, Series A, Vol. 3, No. 3, June, 1951, pp. 281–291.) *Engineers' Digest*, Vol. 13, No. 8, August, 1952, pp. 261, 262, illus.

Effect of Electromagnetic Radiation on the Lamb Shift. F. C. Auluck and D. S. Kothari. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1116, August 7, 1952, pp. 137–142. 7 references.

An Electromagnetic Interpretation Problem for the Sphere. L. B. Slichter. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1118, September 23, 1952, pp. 356–370. 10 references.

The Influence of Sound and Ultrasound on Electro-Chemical Processes. I, II, III. A. Roll. (*Metalloberfläche*, Vol. 4, Nos. 4, 5, and 6, 1952, pp. B49–53; B65–70; 81–89.) *Engineers' Digest*, Vol. 13, Nos. 8, 9, 10, August, September, October, 1952, pp. 257–260, 244; 314–316; 357–360, illus. 17 references.

Multi-Oscillator Processes in the Scattering of Neutrons by Crystals. G. L. Squires. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 212, No. 1109, April 22, 1952, pp. 192–206, illus. 12 references. Results obtained for nickel and magnesium.

A Perturbation Method for Dirac's New Electrodynamics. M. Cini. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1115, July 22, 1952, pp. 520–529. 4 references.

The Phase Transition in Superconductors. I—Nucleation. T. E. Faber. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1118, September 23, 1952, pp. 392–412, illus. 17 references.

The Analogy Between Elastic Solids and Viscous Liquids. V. G. Szebehely and D. H. Pletta. *Virginia Polytechnic Institute, Engineering Experiment Station, Series No. 80*, Vol. 45, No. 1, November, 1951. 24 pp., illus. 21 references.

The Densities and Limiting Densities of Vapours. F. L. Casado, Doreen S. Massie, and R. Whytlaw-Gray. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 207, No. 1091, July 23, 1951, pp. 483–495, illus. 11 references. Experiments at the University of Leeds.

The Dielectric Behaviour of Vapours Adsorbed on Activated Silica Gel. R. McIntosh, E. K. Rideal, and J. A. Snelgrove. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1094, September 7, 1951, pp. 292–310, illus. 28 references.

Dielectric Dispersion in Pure Polar Liquids at Very High Radio-Frequencies. I—Measurements on Water, Methyl, and Ethyl Alcohols. J. A. Lane and J. A. Saxton. **II—Relation of Experimental Results to Theory.** J. A. Saxton. **III—The Effect of Electrolytes in Solution.** J. A. Lane and J. A. Saxton. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vols. 213, 214, Nos. 1114, 1115, 1119, July 8, 22, October 9, 1952, pp. 400–408; 473–492; 531–545, illus. 57 references.

A Discussion on Theory of Liquids. N. F. Mott, J. De Boer, R. Eisenschitz, E. N. da C. Andrade, F. C. Frank, N. N. Greenwood, R. L. Martin, and B. J. Mason. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 215, No. 1120, November 6, 1952, pp. 1–66, illus. 132 references. Comparison of flow in liquids, creep in crystals, and intercrystalline slip; theories of the liquid state; transport processes; analyses of viscosity and supercooling; discontinuities in the physical properties of supercooled liquids; spontaneous nucleation of supercooled water.

An Equation of State Applicable to Gases at Densities near That of the Solid and Temperatures Far Above the Critical. T. L. Cottrell and S. Paterson. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1113, June 24, 1952, pp. 214–225, illus. 17 references.

The Influence of Pressure on the Equilibrium Between Carbon Dioxide and Air. T. J. Webster. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1116, August 7, 1952, pp. 61–71, illus. 10 references.

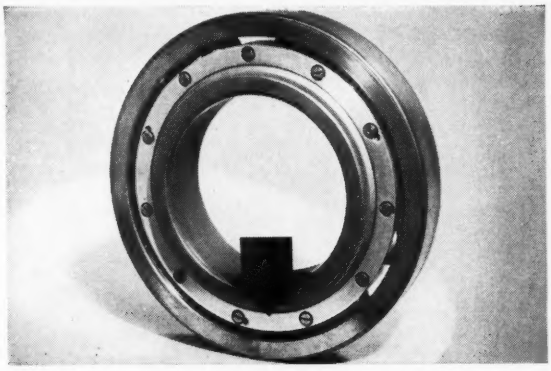
The Limiting Densities of Vapours. F. L. Casado, Doreen S. Massie, and R. Whytlaw-Gray. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1119, October 9, 1952, pp. 466–470, illus. 2 references. Experiments with ethyl ether, carbon tetrachloride, carbon disulphide, perfluoromethylcyclohexane, and acetone.

Molecular Association in Liquids. III—A Theory of Cohesion of Polar Liquids. J. A. Pople. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 215, No. 1120, November 6, 1952, pp. 67–83. 18 references.

Paramagnetic Resonance in the Nickel Tutton Salts. J. H. E. Griffiths and J. Owen. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1115, July 22, 1952, pp. 459–473, illus. 21 references.

'S' Monel...

an extra-hard casting alloy that resists galling and seizing at high temperatures



Takes the brunt of dry starts. Shown here fully assembled is the bearing cage for a jet engine turbine shaft. This bearing runs dry during the first moments of starting, causing a galling problem for the retaining ring. This retaining ring (arrow) between the inner and outer races is a centrifugal sand casting of "S" Monel, cast by Inco. "S" Monel not only offers a high degree of resistance to galling, but also retains its hardness at temperatures up to 1,000° F.

Whenever you're looking for hardness in a corrosion-resisting metal, it's a good idea to review the characteristics of "S"® Monel.

"S" Monel is one of the hardest and strongest of the non-ferrous alloys available in cast forms. What's more, it combines the inherent corrosion resistance of Monel with two particularly valuable features: 1) *extra* hardness at high temperatures, and 2) resistance to *galling and seizing.*

"S" Monel, in fact, maintains a hardness nearly as great as heat treated steel. Temperatures reaching as high as 1,000° F have but slight effect on its hardness.

There have been instances where "S" Monel has shown unusual resistance to seizing, despite poor lubrication – or no lubrication at all!

Another property of "S" Monel is that it is non-magnetic and stays that way at all temperatures down to —70° F.

It is this combination of exceptional properties – and the ability to retain them at high temperatures – that make "S" Monel especially useful for cast precision parts that can be counted on to –

- **take the brunt of high heat**
- **maintain accurate alignment or tight fit**
- **resist galling and seizing**
- **retain their resistance to corrosion, erosion and wear**

You'll find further information on "S" Monel in our bulletin, *Inco Standard Alloys for Special Problems.* Your copy is ready and waiting. Write for it now. And consult your distributor of Inco Nickel Alloys for the latest information on their availability from warehouse and mill. Remember, too—it always helps to anticipate your requirements well in advance.

The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

Mechanical Properties of "S" Monel*
(Age-hardened)

Yield Point	80-115,000 psi
Tensile Strength	120-145,000 psi
Elongation in 2-in.	4-1%
Hardness (Brinell)	300-375
Coefficient of Thermal Expansion (32°-212°F.) in./in/°F.	.0000068

Hardness of "S" Monel at Elevated Temperatures*
(As-cast condition)

Temperature, °F.	Brinell Hardness
Room	321
700	321
800	311
900	311
1000	321
1050	335
1100	293

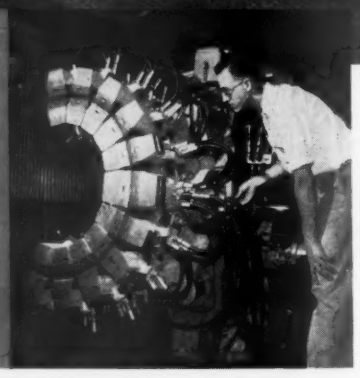
Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
INCONEL® • INCONEL "X"® • INCOLOY® • NIMONICS®
"S"® MONEL • NICKEL • LOW CARBON NICKEL • DURANICKEL®

INCO

ABOVE: Note on this part each jaw is curved oppositely; left jaw concave, right convex. Curves can be widely varied to include even "S" shapes.

RIGHT: Articulated jaw segments show extreme curvature possible



New Hydra-Curve Jaws

ON MODEL 46 HUFFORD

make estimated savings of

$23,797.40

on 200 planes*

By estimating cost of making 30 various parts for 200 planes on different types of forming machines, the Hufford Model 46 equipped with the new Hydra-Curve Jaws showed a material saving alone of $20,180.00! In addition, $3617.40 in labor savings would be effected.

These figures are indicative of the money-saving advantages possible with the new Hufford Hydra-Curve Jaws on Hufford Stretch-Wrap Forming Machines.

BUT MATERIAL SAVINGS ARE NOT ALL... The Hydra-Curve Jaws lower transitional area stresses between die and jaw, reducing sheet breakage losses; overcome wrinkling and insure better skin fits, which cut assembly time. With these new curvable jaws, many jobs are being successfully formed in the "T" condition, saving furnace hours.

DIE COSTS ARE LOWERED TOO because expensive-to-make dish-outs are no longer required to relieve stresses.

If you want new cost reductions, if you want stretch-wrap forming at its best, rely upon Hufford... **FIRST IN THE FIELD, FIRST IN SALES, FIRST IN SAVINGS!**

** All figures from the files of a leading aircraft manufacturer. Name on request.*

HUFFORD
Machine Works Inc.
EL SEGUNDO, CALIFORNIA

Manufacturers of

PRECISION HYDRAULIC STRAIGHTENING PRESSES
HYDRAULIC METAL FORMING BULLDOZERS • HYDRAULIC STRETCH-LEVELING TABLES
HYDRAULIC STRETCH-WRAP FORMING MACHINES
PORTABLE HYDRAULIC ELEVATORS • HYDRAULIC COMPACTION PRESSES
CUSTOM-MADE HYDRAULIC MACHINE TOOLS AND ACCESSORIES

The Spin-Hamiltonian and Line Widths in Nickel Tutton Salts. K. W. H. Stevens. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1117, August 21, 1952, pp. 237–246. 8 references.

Superflow of Helium II Through Narrow Slits. R. Bowers and K. Mendelssohn. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1113, June 24, 1952, pp. 158–174, illus. 5 references.

Boundary Conditions in the Mechanics of Fields. S. M. Neamtan and E. Vogt. *Canadian Journal of Physics*, Vol. 30, No. 6, November, 1952, pp. 684–698. 5 references.

The Brownian Motion of Coupled Systems. P. G. Hodge, Jr. *Journal of Mathematics and Physics*, Vol. 31, No. 2, July, 1952, pp. 120–130. 7 references.

The Classification of Multipole Radiation. Bertha Jeffreys. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 470–481. 12 references.

Mechanism of Mass Transfer on Bubble Plates; Plate Efficiencies. Frank B. West, Walter D. Gilbert, and Toru Shimizu. *Industrial and Engineering Chemistry*, Vol. 44, No. 10, October, 1952, pp. 2470–2478, illus. 20 references.

A Statistical-Mechanical Theory of Surface Tension. A. G. MacLellan. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1113, June 24, 1952, pp. 274–284, illus. 7 references.

Synthesis of a Nonlinear Dynamic Vibration Absorber. Robert E. Roberson. *Franklin Institute, Journal*, Vol. 254, No. 3, September, 1952, pp. 205–220, illus. 8 references. (Based on a Ph.D. thesis.)

Edge Waves on a Sloping Beach. F. Ursell. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1116, August 7, 1952, pp. 79–97, illus. 13 references. Analysis of motion in a semi-infinite canal of finite width.

Space Travel

Astraglossa or First Steps in Celestial Syntax. Lancelot Hogben. *British Interplanetary Society, Journal*, Vol. 11, No. 6, November, 1952, pp. 258–274, illus. A theoretical enlargement of the radio-lexicon of extraterrestrial communication for interplanetary travel.

Manned Flight at the Borders of Space; The Human Factor of Manned Rocket Flight. Heinz Haber. *American Rocket Society, Journal*, Vol. 22, No. 5, September-October, 1952, pp. 269–276, 283, illus. 33 references. (Paper presented at A.R.S., Fall Meeting, Chicago, September 9, 1952.)

Destination Space. S. Vasudev. *Indian Air Force Quarterly*, Vol. 2, No. 4, October, 1952, pp. 64–75, illus. Brief survey; prospects.

Flights To The Major Planetary Systems. H. B. Ketchum. *The Journal of Space Flight*, Vol. 4, No. 9, November, 1952, pp. 1–3.

Structures

An Engineering Method for Estimating Notch-Size Effect in Fatigue Tests on Steel. Paul Kuhn and Herbert F. Hardrath. *U.S., N.A.C.A., Technical Note No. 2805*, October, 1952. 35 pp., illus. 22 references.

Effects of Cyclic Loading on Mechanical Behavior of 24S-T4 and 75S-T6 Aluminum Alloys and SAE 4130 Steel. C. W. MacGregor and N. Grossman. *U.S., N.A.C.A., Technical Note No. 2812*, October, 1952. 53 pp., illus. 4 references.

Evaluating Mechanical Shock Resistance. Bernard Goldberg and T. E. Pardue. (Based on *U.S., Naval Research Laboratory, Report No. PS 105 301.*) *Machine Design*, Vol. 24, No. 7, July, 1952, pp. 236, 238, 241. Sand-cast aluminum alloys used as test materials.

Variation in Strength of Nominally Identical Tail Planes; A Report on Research Revealing the Extent of Scatter in the Strength of Light Alloy Structures Manufactured to the Same Design. K. D. Raithby. *Aircraft Engineering*, Vol. 24, No. 282, August, 1952, pp. 223–225, illus. 1 reference.

Drop Testing a Large Airplane. J. W. Gaines and F. V. Wagner. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 815.* 24 pp., illus.

Theory & Analysis

A Study of Some Impacts Between Metal Bodies by a Piezo-Electric Method. A. W. Crook. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 212, No. 1110, May 7, 1952, pp. 377–390, illus. 11 references. Continuous piezoelectric measurements of the force throughout impacts between cylinders and between a hard sphere and metal flats.

Fatigue—What It Is and Some Ways of Reducing Its Incidence. P. L. Teed. *Society of Licensed Aircraft Engineers, Journal*, Vol. 1, No. 10, October, 1952, pp. 3–15, 20, illus. 20 references. (Paper presented at S.L.A.E. Meeting, Southampton University, Hampshire, England, September 27, 1952.)

Letter to the Editor: The Problem of Fatigue; A Further Comment on the Contributions of Mr. J. Shapiro and Mr. W. A. P. Fisher. G. D. Chapman. *Aircraft Engineering*, Vol. 24, No. 282, August, 1952, p. 240. 2 references.

Chart Simplifies Stress Calculations. Harold M. Durham. *Machine Design*, Vol. 24, No. 8, August, 1952, pp. 179–181, illus. Application of stress nomogram to various problems.

Redundancy of a Structure. P. Narasimha Murthy. *Mechanical Engineer, Bangalore, India*, No. 2, December, 1951, pp. 54–58, illus. 4 references.

Strain Rosette Analysis. H. Fealdman. *The Engineer*, Vol. 194, No. 5042, September 12, 1952, pp. 341, 342, illus. 1 reference. Analysis of results of multi-element wire resistance strain-gage readings.

Application of Maclaurin Series to the Analysis of Beams in Bending. M. Hetényi. *Franklin Institute, Journal*, Vol. 254, No. 5, November, 1952, pp. 369–380, illus. 1 reference.

Creep Collapse of Viscoelastic Columns with Initial Curvatures. Harry H. Hilton. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 844–846, illus. 8 references.

The Elastic Stability of Bent I-Section Beams. J. F. Davidson. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 212, No. 1108, April 8, 1952, pp. 80–95, illus. 13 references.

Lateral Instability of Rectangular Beams of Strain-Hardening Material Under Uniform Bending. W. H. Wittrick. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 835–843, illus. 8 references.

Preliminary Results of Stability Calculations for the Bending of Box Beams with Longitudinally Stiffened Covers Connected by Posts. Roger A. Anderson, Thomas W. Wilder, III, and Aldie E. Johnson, Jr. *U.S., N.A.C.A., Research Memorandum No. L52K10a*, December 1, 1952. 17 pp., illus. 3 references.

Allowable Design Loads for Aluminum Columns. Martin A. Rubinstein. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 197, 199, 201, illus. Nomograms and calculation methods.

Buckling of Low Arches or Curved Beams of Small Curvature. Y. C. Fung and A. Kaplan. *U.S., N.A.C.A., Technical Note No. 2840*, November, 1952. 75 pp., illus. 7 references.

Readers' Forum: Note on the Determination of Bending Frequencies by Rayleigh's Method. F. Niedenfuhr. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 849, 850, illus.

A Note on the Design of Columns Stress Beyond the Yield Point. C. L. Amba Rao. *Mechanical Engineer, Bangalore, India*, No. 2, December, 1951, pp. 46–49, illus. 8 references.

Fundamental Transverse Frequencies Of Tapered Cantilever Bars. Walter W. Soroka. *Product Engineering*, Vol. 23, No. 8, August, 1952, pp. 175–177, illus.

On Non-Uniform Torsion of Cylindrical Rods. Eric Reissner. *Journal of Mathematics and Physics*, Vol. 31, No. 3, October, 1952, pp. 214–221. 9 references.

The Theory of General Instability of Cylindrical Shells. J. R. M. Radok. *College of Aeronautics, Cranfield, England, Report No. 61*, June, 1952. 16 pp. 6 references.

Torsion, Compression, and Bending Tests of Tubular Sections Machined from 75S-T-6 Rolled Round Rod. R. L. Moore and J. W. Clark. *U.S., N.A.C.A., Research Memorandum No. 52I25*, November 12, 1952. 33 pp., illus. 14 references.

Torsion Tests of Aluminum-Alloy Stiffened Circular Cylinders. J. W. Clark and R. L. Moore. *U.S., N.A.C.A., Technical Note No. 2821*, November, 1952. 38 pp., illus. 6 references.

The Analogy Between Elastic Solids and Viscous Liquids. V. G. Szebehely and D. H. Pletta. *Virginia Polytechnic*

Pelican
Waterproof
Drawing Ink
Black
First Choice in 53 Countries!
Unequalled for crisp, sharp-cut delineation, superb PELICAN Drawing Inks permit drawing finest lines without breaking or running. 100% waterproof, free-flowing, fast-drying. Intense opaque black and 19 vivid colors — blendable, dilutable, erases well. In 1-oz. bottles, dropper dispensing cartridges, also larger containers. You'll like
Pelican
WATERPROOF
DRAWING INKS
First Choice in Leading Drafting Rooms and Art Studios
For finer, easier, quicker technical drawing, freehand drawing, sketching, stenciling or lettering, GRAPHOS has no rival. Interchangeable nibs for any line thickness from hairline to 3/8 inch. GRAPHOS cuts "stop-and-fill" time loss 90%. Light touch; perfect balance; uses any drawing ink.
Pelican
Graphos
World's only
DRAWING INK
FOUNTAIN PEN
with 58 Interchangeable Nibs
Ask your dealer or write for illustrated booklets.
JOHN HENSCHEL & CO., Inc.
105 EAST 29th STREET
NEW YORK 16, N. Y.
Sole Distributors for Canada
HEINZ JORDAN & CO.
73 Adelaide St. West, Toronto, Ont., Can.

Institute, Engineering Experiment Station, Series No. 80, Vol. 45, No. 1, November, 1951. 24 pp., illus. 21 references.

Metals Under Stress. S. K. Kabi. *Mechanical Engineer, Bangalore, India*, No. 1, October, 1950, pp. 59–64, illus. 5 references.

On the Stress-Strain Relations of Plastic Deformation. J. P. Benthem. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Report No. S. 398*, December 7, 1951. 107 pp., illus. 31 references.

Stress Strain Relations in the Theory of Thin Elastic Shells. Eric Reissner. *Journal of Mathematics and Physics*, Vol. 31, No. 2, July, 1952, pp. 109–119. 7 references.

A Characteristic Type of Instability in the Large Deflexions of Elastic Plates. I—Curved Rectangular Plates Bent About One Axis. II—Flat Square Plates Bent About All Edges. D. G. Ashwell. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1116, August 7, 1952, pp. 98–118, illus. 16 references.

Diffraction by a Semi-Infinite Metallic Sheet. T. B. A. Senior. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1115, July 22, 1952, pp. 436–458, illus. 28 references.

Elastic Stability of Simply Supported Fiat Rectangular Plates Under Critical Combinations of Longitudinal Bending, Longitudinal Compression, and Lateral Compression. Robert G. Noel. *Journal of the Aeronautical Sciences*, Vol. 19, No. 12, December, 1952, pp. 829–834, illus. 4 references.

Photoelastic Investigation of Transversely Loaded Plates by the Double-Layer Method. A. Kuske. (*Verein deutscher Ingenieure, Zeitschrift*, Vol. 94, No. 22, August 1, 1952, pp. 745–747.) *Engineers' Digest*, Vol. 13, No. 9, September, 1952, pp. 307, 308, illus. 6 references.

The Strength of Curved Stiffened Panels in Shear. P. W. Kleeman. *Australia, Department of Supply, Aeronautical Research Laboratories, Structures and Materials Note No. 196*, January, 1952. 43 pp., illus. 18 references.

Fatigue Life of Wing Components for Civil Aircraft. Keri Williams. *Royal Aeronautical Society, Journal*, Vol. 56, No. 503, November, 1952, pp. 842–848, illus. 8 references.

A Simplified Theory of Swept Wing Deformation. A. H. Hall. *Canada, National Aeronautical Establishment, Structures Laboratory, Report No. LR-28*, June 3, 1952. 41 pp., illus. 2 references.

Thermodynamics

Visualizing Component Environment. W. H. Hannahs, J. A. Caffiaux, and Norman Stein. *Aero Digest*, Vol. 65, No. 2, August, 1952, pp. 82–92, illus. 7 references. Simplified calculations for thermal effects of high-velocity air streams upon the design of aerodynamic enclosures; heat transfer and other thermodynamic properties related to miniaturized design.

The Effects of Organic Substances on the Upper Limits of Inflammability of Some Hydrogen-Carbon Monoxide-Air Mixtures. G. Dixon-Lewis and J. W. Linnet. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1100, December 7, 1951, pp. 48–69, illus. 49 references.

Initiation and Propagation of Explosion in Azides and Fulminates. F. P. Bowden and H. T. Williams. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1093, August 22, 1951, pp. 176–188, illus. 21 references.

The Oxidation of Hexane in the Cool-Flame Region. H. C. Bailey and R. G. W. Norrish. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 212, No. 1110, May 7, 1952, pp. 311–330, illus. 22 references.

Predissociation in the Spectrum of OH; the Vibrational and Rotational Intensity Distribution in Flames. A. G. Gaydon and H. G. Wolfhard. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1092, August 7, 1951, pp. 63–75, illus. 12 references.

Spectra of Flames Supported by Free Atoms. A. G. Gaydon and H. G. Wolfhard. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1114, July 8, 1952, pp. 366–379, illus. 14 references.

Spectroscopic Studies of the Hydrogen-Oxygen Explosion Initiated by the Flash Photolysis of Nitrogen Dioxide. R. G. W. Norrish and G. Porter. *Royal Society (London) Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1103, January 22, 1952, pp. 439–460, illus. 20 references.

Thermal Decomposition and Explosion of Azides. A. D. Yoffe. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1093, August 22, 1951, pp. 188–199, illus. 21 references.

An Experimental Investigation of Protection Achieved by Sweat Cooling on Porous Surfaces Adjacent to Non-Porous Surfaces. E. Duncombe. (*Canada, National Research Council, Division of Mechanical Engineering, Report No. MT-20*, January, 1951.) *Canada, National Aeronautical Establishment, Report No. 16*, 1952. 31 pp., illus. 16 references.

On the Physical Significance of Some Dimensionless Groups in the Theory of Heat Transfer. P. Srinivasa Row. *Mechanical Engineering, Bangalore, India*, No. 2, December, 1951, pp. 34–45, illus.

The Temperature Distribution Along a Radiating Gas Stream in Which Heat Is Being Liberated by a Chemical Reaction. M. W. Thring. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1093, August 22, 1951, pp. 247–262, illus. 7 references.

The Thermal Conductivities of Some Dielectric Solids at Low Temperatures (Experimental). R. Berman. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1092, August 7, 1951, pp. 90–108, illus. 22 references.

sps aircraft fasteners

UNBRAKO®

STANDARD "SIX-DIGIT" ENGINE BOLTS

All listed diameters—hex and internal wrenching types. AN specifications.

NAS SHEAR BOLTS

Close tolerance, high strength, flush head type.

NAS INTERNAL WRENCHING LOCK NUTS

Superior safety nuts. Sizes from ¼" to 1½".

NAS INTERNAL WRENCHING AIRCRAFT BOLTS

Latest NAS specifications. Threads are fully formed by rolling after heat treatment.

INFORMATION UPON REQUEST. ADDRESS DEPARTMENT 678.

FLEXLOC®

FLEXLOC SELF-LOCKING NUTS, REGULAR TYPE

Both stop and lock nuts. One piece construction, resilient segments lock positively with uniform torque. Aircraft approval, sizes #4 to 1¼" inclusive. Regular steel FLEXLOC approved for temperatures to 550°F.

FLEXLOC SELF-LOCKING NUTS, THIN TYPE

Less than regular height, yet conform to accepted standards. Every thread, including the locking threads, carries its share of load. Have all regular FLEXLOC features, but save weight and height. Aircraft approval, #6 to 1¼".

FLEXLOC EXTERNAL WRENCHING NUTS

Incorporate famous FLEXLOC self-locking principle and one-piece, all-metal construction. Latest NAS specifications. Sizes from ¼" to 1½" NF Thread Series. Approved for temperatures to 550°F.

INFORMATION ABOUT FLEXLOC ON REQUEST. ADDRESS DEPARTMENT 51,

AIRCRAFT PRODUCTS DIVISION

STANDARD PRESSED STEEL CO., JENKINTOWN 58, PENNSYLVANIA

The Thermal Conductivity of Dielectric Solids at Low Temperatures (Theoretical). P. G. Klemens. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 208, No. 1092, August 7, 1951, pp. 108–133, illus. 18 references.

The Thermo-Osmosis of Gases Through a Membrane. I—Theoretical. II—Experimental. K. G. Denbigh and Gertrud Raumann. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, Nos. 1102, 1103 January 7, 22, 1952, pp. 377–387; 518–533, illus. 37 references.

The Thermal Conductivity of Solid Helium. F. J. Webb, K. R. Wilkinson, and J. Wilks. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 214, No. 1119, October 9, 1952, pp. 546–563, illus. 37 references.

Design and Arrangement of Cooling Fins. F. Heiles. (*Elektrotechnik und Maschinebau*, Vol. 69, No. 14, July, 1952, pp. 323–331.) *Engineers' Digest*, Vol. 13, No. 10, October, 1952, pp. 343–346, illus. 6 references. For enclosed electrical machines.

The Free Convection Cell in Two Dimensions. A. F. Pillow. *Australia, Department of Supply, Aeronautical Research Laboratories, Report No. A. 79*, May, 1952. 31 pp., illus. 15 references.

Measurement of the Thermal Accommodation Coefficients of Gases. A. E. J. Eggleton, F. C. Tompkins, and D. W. B. Wanford. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 213, No. 1113, June 24, 1952, pp. 266–273, illus. 6 references. Experiments with tungsten.

The Thermodynamics of Combustion Gases: General Considerations. Stuart R. Brinkley, Jr., and Bernard Lewis. *U.S., Department of the Interior, Bureau of Mines, Report of Investigations No. 4806*, April, 1952. 61 pp., illus. 23 references.

The Significance of the Thermal Number in Metal Machining. B. T. Chao and K. J. Trigger. (*American Society of Mechanical Engineers, Semi-Annual Meeting, June 15–19, 1952, Paper No. 52-SA-58.* 14 pp.) *Engineers' Digest*, Vol. 13, No. 9, September, 1952, pp. 311–313, illus. 7 references.

The Transients Arising from the Addition of Heat to a Gas Flow. P. M. Stocker. *Cambridge Philosophical Society, Proceedings*, Vol. 48, Part 3, July, 1952, pp. 482–498, illus. 5 references.

The Thermal Decomposition of Barium Azide. J. G. N. Thomas and F. C. Tompkins. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1100, December 7, 1951, pp. 111–125, illus. 12 references.

Water-Borne Aircraft

High-Speed Water-Based Aircraft. Ernest G. Stout. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 814.* 20 pp., illus. 4 references. Historical survey and technical design development; military and civilian applications.

Engine Modification Improves (Grumman) Widgeon (G-44). *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 72, 73, illus.

The Navy's Patrol Planes. *United States Naval Institute, Proceedings*, Vol. 78, No. 12, December, 1952, pp. 1356–1365, illus. Designs from the 1914 Glen Curtiss's America to the 1952 P5M and P54.

Waterbased Jet Airliners Advocated to Pass Foreign Competition. R. Raymond Kay. *Automotive Industries*, Vol. 107, No. 9, November 1, 1952, pp. 48, 49, 114, 116, 118, 120, illus. Discussion of engineering problems involving materials, production, and operation of supersonic aircraft at the S.A.E. National Aeronautic Meeting, Los Angeles, October, 1952.

Why Not A Jet Transport Seaplane? *Western Aviation*, Vol. 32, No. 11, November, 1952, p. 11, illus. Some problems.

A Theoretical Investigation of the Effect of Partial Wing Lift on Hydrodynamic Landing Characteristics of V-Bottom Seaplanes in Step Impacts. Joseph L. Sims and Emanuel Schnitzer. *U.S., N.A.C.A., Technical Note No. 2815*, November, 1952. 20 pp., illus. 3 references.

Theory and Procedure for Determining Loads and Motions in Chine-Immersed Hydrodynamic Impacts of Prismatic Bodies. Emanuel Schnitzer. *U.S., N.A.C.A., Technical Note No. 2813*, November, 1952. 51 pp., illus. 18 references.

Water-Pressure Distributions During Landings of a Prismatic Model Having an Angle of Dead Rise of 22½° and Beam-Loading Coefficients of 0.48 and 0.97. Robert F. Smiley. *U.S., N.A.C.A., Technical Note No. 2816*, November, 1952. 37 pp., illus. 8 references.

A Theoretical and Experimental Investigation of the Effects of Yaw on Pressures, Forces, and Moments During Seaplane Landings and Planing. Robert F. Smiley. *U.S., N.A.C.A., Technical Note No. 2817*, November, 1952. 98 pp., illus. 25 references.

The Application of Planing Characteristics to the Calculation of the Water-Landing Loads and Motions of Seaplanes of Arbitrary Constant Cross Section. Robert F. Smiley. *U.S., N.A.C.A., Technical Note No. 2814*, November, 1952. 37 pp., illus. 23 references.

Draft Corrections for Water Surface Deflection under No. 1. Carriage of the R.A.E. Seaplane Tank. T. B. Owen. *Gt. Brit., Aeronautical Research Council, Current Papers No. 67*, 1952 (March, 1950). 15 pp., illus. 5 references. British Information Services, New York. $1.00.

Wind Tunnels & Research Facilities

Aerial Prospecting for Radio Active Materials. E. A. Godby, S. H. G. Connock, J. F. Steljes, G. Cowper, and H. Carmichael. *Canada, National Research Council, Laboratories, Divisions of Mechanical Engineering and Atomic Energy, Joint Report Nos. MR-17, CRR-495*, March 13, 1952. 88 pp., illus. 10 references.

Government Collaboration in Aircraft Development. S. Scott Hall. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 764.* 25 pp., illus.

Artificial Weather for Guided Missiles. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 60–65, illus. Goodyear Aircraft Corp.'s 440 cu. ft. environmental test chamber.

Facilities and Equipment for Testing High Speed Aircraft. J. S. Holtoner and F. J. Ascani. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 759.* 18 pp., illus. A.F. Flight Test Center at Edwards A.F.B.

Flight Test and Facilities for Naval Aircraft. W. V. Davis, Jr. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 760.* 16 pp., illus. Organization and facilities of the Naval Air Test Center, Patuxent River, Md.

Flying Laboratories; Special High-Speed Test Planes Compile Vital Aëronautical Data. Walter T. Bonney. *Ordnance*, Vol. 37, No. 195, November-December, 1952, pp. 418–421, illus.

It Takes A Jet to Test a Jet; A Paper on G-E's B-45 Flying Test Bed. Walter E. Stanger and Weldon R. Orme. *S.A.E., National Aeronautic Meeting, Los Angeles, October 1–4, 1952, Preprint No. 833.* 10 pp., illus.

Mechanical "Nose" Guards Jet Production. *Aviation Age*, Vol. 18, No. 5, November, 1952, pp. 69–71, illus. Mine Safety Appliance Company's vapor analyzing and alarm instruments for safeguarding turbojet-engine test cells and fuel tanks.

Metals Processing Laboratory (at M.I.T.). *Technology Review*, Vol. 55, No. 2, December, 1952, pp. 89–92, 120, 122, illus.

A Modern Engine Test Plant. Bo Hoffstrom. *S.A.E., National Aeronautic Meeting, New York, April 21–24, 1952, Preprint No. 762.* 20 pp., illus. Design criteria, service experience, and cost data.

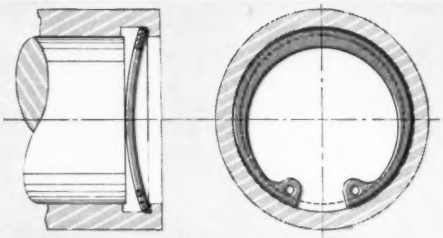
The Research Laboratories of Associated Electrical Industries Ltd. I—The Laboratory Organizations of the A.E.I. Group and the Fundamental Research Laboratory of the A.E.I. Arthur Fleming. **II—The Research Department of the Metropolitan-Vickers Electrical Company Limited.** B. G. Churcher. **III—The Research Laboratory, The British Thomson-Houston Company Limited, Rugby.** L. J. Davies. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 210, No. 1101, December 20, 1951, pp. 145–172, illus. 3 references.

Some Aspects of Research at the Royal Aircraft Establishment. *The Engineer*, Vol. 194, No. 5045, October 3, 1952, pp. 466, 467, illus.

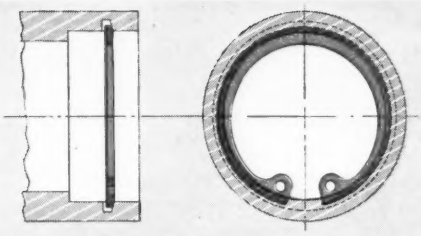
The Aerodynamic Drag of a Free Water Surface. J. R. D. Francis. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 206, No. 1086, May 7, 1951, pp. 387–406, illus. 23 references. Measurements in a 7.5 cm. by 7 m. tunnel in which winds up to 14 m. per sec. can be made.

Edge Waves on a Sloping Beach. F. Ursell. *Royal Society (London), Pro-*

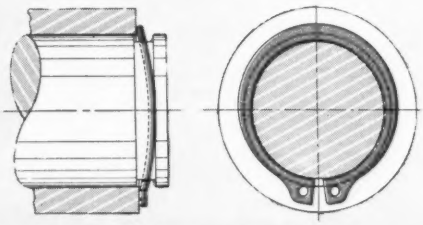
if end-play take-up is a problem
one of these special Waldes Truarc rings can solve it



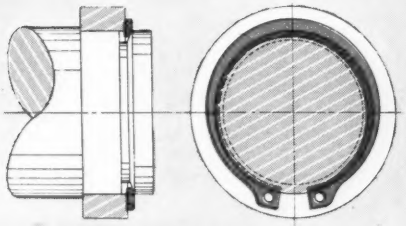
series 5001 · internal type
for bore diameters from: .250 — 1.456 in.



series 5002 · internal type
for bore diameters from: 1 — 10 in.



series 5101 · external type
for shaft diameters from: .188 — 1.438 in.



series 5102 · external type
for shaft diameters from: 1 — 10 in.

bowed WALDES TRUARC RETAINING RINGS

Take up end-play resiliently, damp vibrations and oscillations. Bent like a bow out of plane at horizontal center line. The bowed Truarc ring acts in axial direction like a floating spring without losing its tight grip against the bottom of the groove.

Maximum resilient end-play take-up: .015" to .020" depending on size of ring.

beveled WALDES TRUARC RETAINING RINGS

Take up end-play rigidly. When the ring is contracted (or expanded), the tapered edge acts like a wedge moving deeper into the groove and shifting in an axial direction until the ring abuts the machine part.

Maximum end-play take-up, depending on ring size: internal types, .005" to .043"; external types, .005" to .040".

WALDES TRUARC is much more than a better way to hold parts together

Thousands of manufacturers have already found that Truarc Retaining Rings cut production costs and speed assembly by simplifying product design. But that's not all.

Waldes Truarc engineers have extended the use of retaining rings by developing rings that perform *additional functions* while acting as retaining shoulders. Those shown here take up end-play, compensate for wear and varying manufacturing tolerances.

No matter what your problem, there's a Waldes Truarc Ring designed specifically to solve it. Send us your drawings, your questions—Waldes Truarc engineers will work with you, at no obligation.

SEND FOR NEW CATALOG

WALDES
TRUARC
REG. U. S. PAT. OFF.
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,382,947; 2,382,948; 2,416,851; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name.....

Title.....

Company.....

Business Address.....

City.....Zone.....State.....

DEPARTMENT OF TECHNOLOGY
BUFFALO PUBLIC LIBRARY
AE-025

ceedings, Series A, Mathematical and Physical Sciences, Vol. 214, No. 1116, August 7, 1952, pp. 79–97, illus. 13 references. Design of wave-maker.

An Experimental Study of the Pressure Variations in Standing Water Waves. R. I. B. Cooper and M. S. Longuet-Higgins. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 206, No. 1086, May 7, 1951, pp. 424–435, illus. 5 references. Description of wooden tank.

Flow Structure and Pressure Recovery in a Supersonic Open Jet Wind Tunnel. J. G. Hall. *Canada, National Aeronautical Establishment, Aerodynamics Laboratory, Report No. LR-19*, November 7, 1951. 38 pp., illus. 4 references.

Comparative Tests of Thick and Thin Turning Vanes in the Royal Aircraft Establishment 4 × 3-ft Wind Tunnel. K. G. Winter. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2589*, 1952 (August, 1947). 5 pp., illus. 6 references. British Information Services, New York. $0.50.

The No. 2, 11½-ft. × 8½-ft. Wind Tunnel at the Royal Aircraft Establishment, Farnborough. D. C. MacPhail, J. G. Ross, and E. C. Brown. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda, No. 2424*, 1951 (August, 1945). 55 pp., illus. 21 references. British Information Services, New York. $3.50.

Methods for Windtunnel Measurements of Models of Vehicles, Vessels and Constructions. A. De Lathouder. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Report No. A. 1241*, 1951. 5 pp., illus.

Pressure Plotting Tests in the Royal Aircraft Establishment High Speed Wind Tunnel on a 21 per cent Thick, Low Drag Aerofoil (Brabazon I Wing Root Section). A. B. Haines. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2617*, 1952 (October, 1947). 24 pp., illus. 7 references. British Information Services, New York. $1.50.

Windtunnel Is a Firing Range. *Aviation Week*, Vol. 57, No. 16, October 20, 1952, p. 35, illus. Ames Aeronautical Laboratory's supersonic free-flight wind tunnel for missiles research.

The Wind Tunnel, The Basic Research Equipment in Aeronautical Engineering. O. G. Tietjens. *Mechanical Engineer, Bangalore, India*, No. 2, December, 1951, pp. 1–9, illus.

Corrections for Drag, Lift, and Moment of an Axially Symmetrical Body Placed in a Supersonic Tunnel Having a Two-Dimensional Pressure Gradient. I. J. Kolodner, F. Reiche, and H. F. Ludloff. *U.S., N.A.C.A., Technical Note No. 2837*, November, 1952. 45 pp. 2 references.

Simulation of Linearized Dynamics of Gas-Turbine Engines. J. R. Ketchum and R. T. Craig. *U.S., N.A.C.A., Technical Note No. 2826*, November, 1952. 25 pp., illus. 7 references.

The Upwash Correction for an Oscillating Wing in a Wind Tunnel. Theodore R. Goodman. *Cornell Aeronautical Laboratory, Inc., Report No. AD-744-W-1*, July, 1951. 19 pp., illus. 8 references.

Wall Interference in Wind Tunnels of Closed Rectangular Section: Development of Equations. J. Sanders and J. R. Pounder. *Canada, National Research Council, Aeronautical Report No. AR-11 (N.R.C. 2600)*, 1951. 28 pp., illus. 13 references.

Wind Tunnel Interference on Rolling Moment of a Rotating Wing. P. Mandl and J. R. Pounder. *Canada, National Research Council, Aeronautical Report No. AR-10 (N.R.C. 2570, MA-216)*, 1951. 31 pp., illus. 9 references.

Design of High Speed Wind Tunnels. A. Ramachandran. *Mechanical Engineer, Bangalore, India*, No. 2, December, 1951, pp. 10–18, illus. 25 references.

The High Speed Wind Tunnel at the Royal Aircraft Establishment, S. Farnborough (With Special Reference to Welding, Shop Assembly and Site Erection). J. H. Bell. *Institute of Welding, Transactions*, Vol. 15, No. 5, October, 1952, pp. 133–143, illus.

High-speed Wind-Tunnel Tests on Models of Four Single-engined Fighters (Spitfire, Spiteful, Attacker, and Mustang). Parts 1–5. W. A. Mair (Editor). *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2535*, 1951 (April, 1945). 79 pp., illus. 2 references. British Information Services, New York. $4.50.

Investigation of a Diffraction-Grating Interferometer for Use in Aerodynamic Research. James R. Sterrett and John R. Erwin. *U.S., N.A.C.A., Technical Note No. 2827*, November, 1952. 36 pp., illus. 12 references.

A Visit to Project Snort. James B. Kendrick. *Aviation Age*, Vol. 17, No. 2, August, 1952, pp. 47–53, illus. Facilities and techniques of the supersonic research track for high-speed guided missiles and aircraft under construction at the Naval Ordnance Test Station, Pasadena, Calif.

Eighth International Congress on Theoretical and Applied Mechanics

(*Concluded from page 50*)

sponsored by the United Nations Educational, Scientific and Cultural Organization. It collaborates with the International Congress Committee, and many of its members are also members of the committee. The International Union of Theoretical and Applied Mechanics consists of representatives of all the adhering national organizations, as well as of persons who were elected members in their own right. In this latter category H. L. Dryden, J. C. Hunsaker, Th. von Kármán, R. von Mises, and S. Timoshenko belong to the Union. The American National Delegates to the Union are designated by the U.S. National Committee for Theoretical and Applied Mechanics. They are H. W. Emmons, N. J. Hoff, R. D. Mindlin, M. G. Salvadori, and R. J. Seeger. All of the American delegates with the exception of Th. von Kármán were present at the meeting in Istanbul. During the 4-year interval between 1952 and 1956, the following persons will serve as officers of the International Union for Theoretical and Applied Mechanics: H. L. Dryden, President; J. Pérès, Vice-President; F. H. van den Dungen, Secretary (until 1954); G. Temple, Treasurer; M. Roy, N. J. Hoff, and J. M. Burgers, Assistant Treasurers; K. Erim, R. Grammel, J. M. Burgers, and F. K. Odqvist (until 1954) members of the Executive Committee.

A COMPLETE MEDIA PACKAGE

FOR YOUR

Aviation Marketing Program

AERONAUTICAL ENGINEERING REVIEW

For your monthly advertising messages to the aircraft industry's engineering and design personnel—the men who influence buying.

AVIATION MARKET BOOK Now Available!

16 pages of FACTS on your market and REVIEW.

Write for your free copy TODAY!

AERONAUTICAL ENGINEERING CATALOG

Prefiles and distributes your aircraft products catalog to aviation's buyers and specifiers.

7,000 copies are distributed annually to aircraft engineers, designers, technicians and purchasing agents in all leading aircraft, engine and parts companies, Government aviation departments and leading air lines.

Write for your free copy of 12-page MARKET BOOK giving full details.

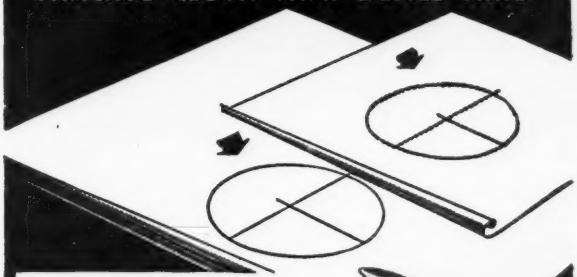
OFFICIAL PUBLICATIONS:

INSTITUTE OF THE AERONAUTICAL SCIENCES

2 East 64th Street New York 21, N.Y.

Imperial

TRACING CLOTH THAT DEFIES TIME



● The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

Imperial takes erasures readily, without damage. It gives sharp contrasting prints of even the finest lines. Drawings made on Imperial over fifty years ago are still as good as ever, neither brittle nor opaque.

If you like a duller surface, for clear, hard pencil lines, try Imperial Pencil Tracing Cloth. It is good for ink as well.

Imperial TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE

Lightning Response BY SUMMERS

Model 120 Integrating Motor, for

• INTEGRATION • SERVO MECHANISMS • AUTOMATIC CONTROLS

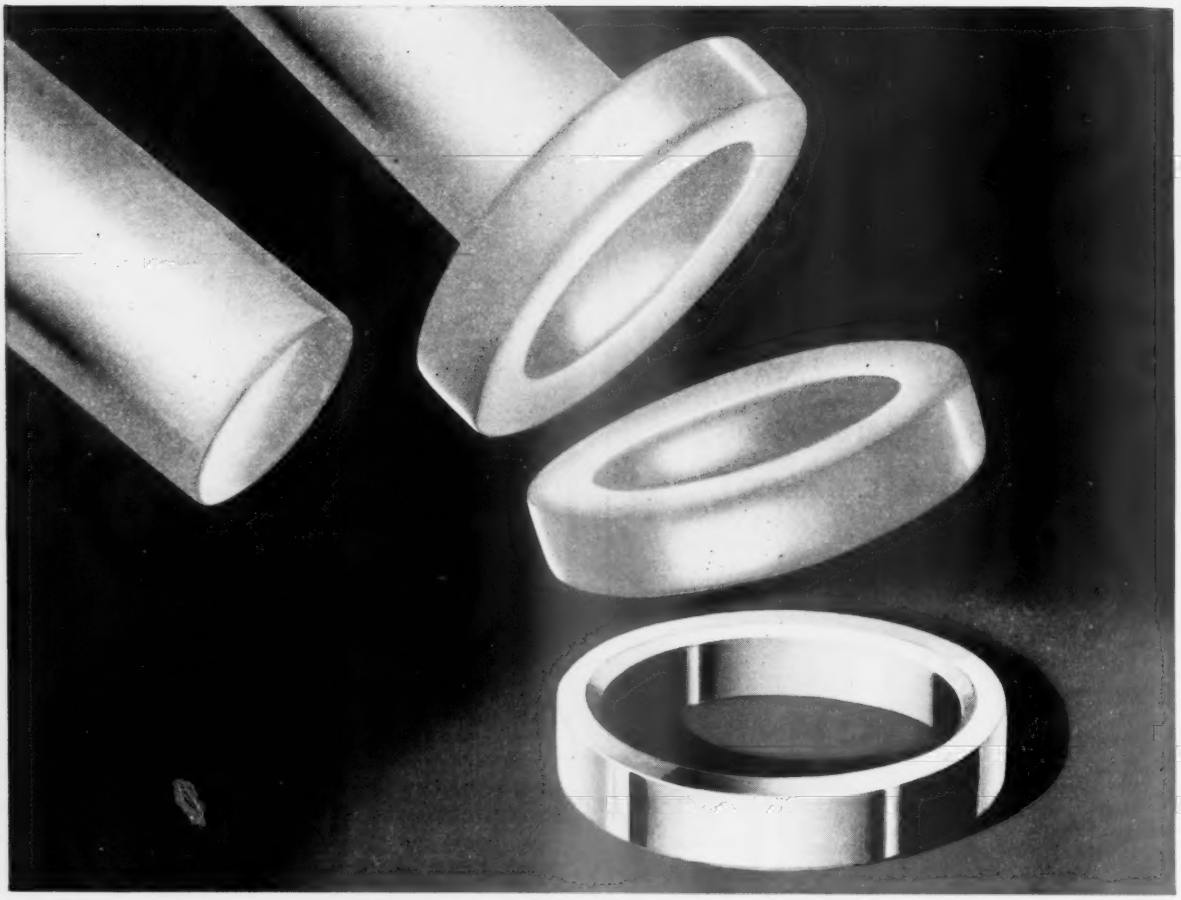
Acceleration Time Constant . . . . . 0.003 second
Torque-to-inertia ratios in the order of 10^4 to 10^6 seconds $^{-2}$

The integrating motor is fitted with precision gear train and a 5 watt potentiometer. Special output mechanisms tailored to customer requirements.

NO KNOWN MOTOR can . . . dynamically outperform the Model 120 in its . . . power classification.

Immediate Openings for
ENGINEERS • GYRO TECHNICIANS
DRAFTSMEN

Summers GYROSCOPE CO.
2328 BROADWAY, SANTA MONICA, CALIF.



Forged-in Quality means Longer Life for Eaton Valve-Seat Inserts

Eaton steel valve-seat inserts are made from hot-upset and pierced blanks. The forging process improves the physical characteristics of the steel, and provides superior wearing qualities in the finished inserts.

The Eaton Saginaw Division is equipped by years of experience, and modern specialized equipment for the high-volume production of seat inserts in all types and sizes—iron and steel, puddled or plain—for aircraft, motor cars, trucks, tractors, and Diesel engines.

EATON

EATON MANUFACTURING COMPANY

General Offices: CLEVELAND, OHIO

SAGINAW DIVISION: 9771 FRENCH ROAD • DETROIT 13, MICHIGAN

EATON PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

Aeronautical Reviews — BOOKS

Grundlagen der Aeromechanik und Flugmechanik

By Arthur Pröll. Vienna, Springer-Verlag, 1951. 612 pp., figs. $11.50. (In German.)

The author of this book is well known as a professor of aeronautics who has been active in teaching and writing since the first World War. The author's aim is to provide a book that welds the fundamental mathematical-physical concepts of fluid mechanics to those more or less technical aspects of flight and flight dynamics. The first part of the book is entitled Basic Aerodynamics and the second Flight Mechanics.

A translation of the chapter headings may serve to convey to the reader the contents of this volume:

FIRST PART—BASIC AERODYNAMICS

(A) PHYSICAL FUNDAMENTALS

(1) Properties of the air mass
(2) Air resistance

(B) MATHEMATICAL RELATIONS OF AERODYNAMICS

(I) Flow Kinematics

(3) General three-dimensional flows
(4) Two-dimensional flows
(5) Theoretical relations and computation
(6) Two-dimensional flow around a cylinder
(7) Further applications of potential flows with sources and vortices

(II) Flow Dynamics

(8) Dynamic pressure, impulse
(9) Lift of a flow around a circular cylinder with circulation
(10) Euler's equations
(11) Bernoulli's equation
(12) Energy content of fluid flows
(13) Nonsteady and dividing surfaces

(III) Conformal Representations and the Aerodynamics of Profiles

(14) General theory
(15) Examples of conformal representations
(16) Theory of lifting profiles
(17) General survey for the choice of a profile
(18) Cascade flow
(19) Supervelocities
(20) The singularity method for thin airfoils (Birnbaum's technique)
(21) The hodograph method
(22) Axially symmetric flow phenomena

(IV) Flows with Resistance

(23) Resistance of the inner friction
(24) The laminar boundary layer
(25) The turbulent boundary layer on a flat plate
(26) Experimental determination of profile drag
(27) Means of preventing separation
(28) Motion of bodies in still media

(V) Lifting Wings with Finite Span

(29) Statement of problem (lift distribution, induced drag)
(30) Examples for induced drag (monoplane)
(31) Biplane

(VI) Gas Dynamics

(32) Basic gas dynamics and principal problems (supersonic flight)

SECOND PART—FLIGHT MECHANICS

(I) Theoretical and Practical Design Elements

(33) Introduction
(34) Principal diagrams of flight mechanics

(II) Performance

(35) The propulsion of the airplane
(36) Theory of the propeller
(37) Application of screw theory
(38) Choice and computational procedure of propellers
(39) Combined operation of engine, propeller, and airplane

(III) The Speed Performance of the Airplane

(40) The speed in the horizontal plane
(41) Preliminary design of an airplane
(42) Flight mechanical considerations according to the computations of M. Schrenk

(IV) Climb Performance of an Airplane

(43) General preliminary thoughts, flight at low altitudes (constant density)
(44) High-altitude climbs (variable density)
(45) Climb at steep angles
(46) Numerical examples (climbing flight)
(47) Flight at high altitudes

(V) Special Performance Problems of Airplanes

(48) The range of an airplane

(VI) Nonstationary Flight Conditions

(49) Accelerated flight condition
(50) Take-off and landing
(51) Influence of small variations of the principal parameters

(VII) Flight Properties Stability of the Airplane

(52) Center of pressure and moment of flat and cambered surfaces
(53) Static longitudinal stability: moment equilibrium
(54) Static stability of the airplane
(55) Static directional and lateral stability

(VIII) Dynamic Stability of the Airplane

(56) General introduction
(57) Dynamic stability and longitudinal oscillations
(58) Flight mechanical amplification of general longitudinal motions
(59) Control and controllability
(60) Dynamic lateral stability
(61) Dynamic directional stability
(62) An additional example for coupled airplane motions
(63) Autorotation
(64) Spins
(65) Remarks on the statics of airplanes
(66) Forces and their distribution
(67) Statics of airplane parts

The book concludes with an index of names and one of subjects.

Examination of the foregoing contents will convince the reader that

For information on I.A.S. Library Service Facilities, see page 80

Statements and opinions expressed in Book Reviews are to be understood as individual expressions and not necessarily those of the Institute.

Professor Pröll has actually fulfilled his aim to include in one volume the principal material contained in such books as Durand's *Aerodynamic Theory* or Prandtl-Tietjens encyclopedic work.

On reading the book, one is immediately impressed with the fact that it follows the classical approach in every respect. Only the absolutely basic concepts are offered. Even the references follow this conservative approach. The few references to the German work done during or just prior to World War II may be due to Professor Pröll's conservative and classical approach or else to his inability to obtain those war papers of sufficient importance for inclusion in his book.

There are many graphical approaches to performance which are unique in their simplicity and their directness. A study of these graphical approaches would, the reviewer believes, be useful to many preliminary designers.

Concerning the Schrenk method of performance evolution, it should be mentioned that this method is essentially the Oswald performance computation method, both methods utilizing the equivalent parabolic polar for the airplane.

For those American engineers who read German, this book would be a useful addition to their libraries because of its conciseness and clarity. University lecturers will find in this book much valuable supplemental work to such standard English works as Perkins and Hage on performance and stability and Duncan on stability. Because it lacks recent references and offers little in nonclassical work, the research worker may not find this volume as useful as other less conservative works.

DR. AUGUST RASPET
Head, Aerophysics Department
Engineering Research Station
Mississippi State College

Instrument Engineering. Vol. 1, Fundamentals

By C. S. Draper, Walter McKay, and Sidney Lees. New York, McGraw-Hill Book Company, Inc., 1952. 288 pp., diagrs., figs. $6.00.

Instrument Engineering is written for those who intend to design or evaluate complex types of instrument-regulating or servo systems. This type of complex system is presently associated to a large degree with the performance and control of high-speed aircraft and missiles. Because of the nature of the subject, this work is particularly suitable for advanced students taking the instrument engineering course and for those who have adopted instrument design and development as a profession after graduation.

Instrument Engineering is divided into three volumes. Volume 1 deals with methods of analyzing and expressing instruments. Volume 2 describes methods of associating mathematical solutions with the forms developed in Volume 1. In Volume 3, the application of "Instrument Engineering" methods to typical problems is described.

Volume 1 develops a method for taking simple instrument systems, breaking them down into components and input and output functions. It expresses the performance of the instrument by developing symbols with a specific meaning for each type of component, depending upon the function of the component, in the instrument system. The system for symbolizing functions is developed to an elaborate state.

These functions are broken down into primary as well as other functions, such as interfering and modifying functions of various orders and magnitudes.

The author analyzes static and dynamic systems by means of block diagrams, vectorial methods, and performance curves of various types. This is in addition to describing methods of expressing various functions and analyzing them by the means already described.

The latter part of the book describes methods of expressing certain systems in mathematical terms. Volume 1 can be used as a tool by the instrument engineer to express himself by means of symbols and forms which may be universally understood by others in this field. This will enable him to proceed to Volume 2 where the forms of the various instrument systems will assume mathematical significance capable of solution.

It is the opinion of the reviewer, who has been associated with instrument system design for the past seventeen years, that *Instrument Engineering*, in the hands of young engineers who intend to specialize in this field, will be a valuable asset. It will enable them to expedite greatly the design and development of instrument systems.

This advantage will be forthcoming as a result of the orderly and mathematical approach to the problem rather than the cut and try methods previously employed to a large extent in this field.

JAMES E. BEVINS
Chief Engineer
Mechanical Accessories Section
Eclipse-Pioneer Division
Bendix Aviation Corporation

Book Notes

MATERIALS

Advanced Mechanics of Materials. Fred B. Seely and James O. Smith. 2nd Ed. New York, John Wiley & Sons, Inc., 1952. 680 pp., diagrs., figs. $8.50.

Since the first edition of this work was published in 1932, many important contributions have been made to the subject of mechanics of materials, and as a consequence the treatment in this edition has been made more comprehensive and much new material has been added. The book was prepared primarily for advanced undergraduate and first-year graduate students in engineering, with the needs of design and research engineers being kept in mind. In fact, this second edition is essentially a new book. The book consists of six parts, two new parts having been added: The Influence of Small Inelastic Strains on the Load-Carrying Capacity of Members, and Introduction to Instability—Buckling Loads. Useful material not previously published has also been presented on a number of the topics throughout the book. Two new appendixes have been added. Fred B. Seely is Professor Emeritus of Theoretical and Applied Mechanics, University of Illinois; James O. Smith is Professor of Theoretical and Applied Mechanics.

Contents: Part I, Preliminary Considerations. (1) Analysis of Subject. (2) Elementary Stress Formulas for Static Loads. (3) Stresses and Strains at a Point, Theories of Failure by Yielding.

Part II, Special Topics on the Strength and Stiffness of Members Subjected to Static Loads. (4) Shear Center for a Cross Section of a Beam. (5) Unsymmetrical Bending. (6) Curved Flexural Members. (7) Beam on Continuous Elastic Support. (8) Flat Plates. (9) Torsional Resistance of Bars Having Non-Circular Cross Sections. (10) Thick-Walled Cylinders. (11) Contact Stresses.

Part III, Localized Stress—Stress Concentration. (12) Values and Significance of Localized Stresses in Various Members.

Part IV, Energy Methods. (13) Considerations of Energy Principles for Determining Relations Between Loads and Deflections. (14) Deflection of Members and Simple Structures by Castigliano's Theorem. (15) Deflection of Members and Simple Structures by Unit Load or Dummy Load Method. (16) Forces and Moments in Statically Indeterminate Members and Structures.

Part V, Influence of Small Inelastic Strains on the Load-Carrying Capacity of Members. (17) Effect of Small Inelastic Strains in Axially Loaded Members and in Straight Beams. (18) Effect of Small Inelastic Strains for Combined Bending and Axial Loads. (19) Introduction to Ultimate Load Analysis of Statically Indeterminate Members.

Part VI, Introduction to Instability—Buckling Load. (20) Elastic and Inelastic Buckling of Columns. (21) Buckling of Cylindrical Tubes Under Uniform External Pressure.

Appendix I, A Brief Introduction to the Mathematical Theory of Elasticity. Appendix II, The Elastic-Membrane (Soap-Film) Analogy for Torsion. Appendix III, Properties of an Area. Index.

POWER PLANTS

Fundamentals of Internal Combustion Engines; As Applied to Reciprocating, Gas Turbine, and Jet Propulsion Power Plants. Paul W. Gill, James H. Smith, Jr., and Eugene J. Ziurys. Annapolis, The United States Naval Institute, 1952. 566 pp., illus., diagrs., figs. $5.00.

This textbook was prepared primarily for use in the first-class year at the U S. Naval Academy. The purpose of the text is to present the basic theory, fundamental principles, and performance characteristics of the three major categories of internal combustion engines—the spark ignition engine, the compression ignition engine, and the gas turbine. A secondary purpose is to acquaint the student with the nomenclature of the various component parts of these engines, the capabilities and limitations of the various types of power plants, current development trends, and future applications.

The text is arranged in two distinct parts. Part I, more than half of the book, covers the reciprocating types of internal combustion engines—i.e., the compression ignition and spark ignition power plants. The second part of the text is devoted to the gas turbine, particularly as applied to shipboard installations and the jet propulsion field.

Series motor suitable for many intermittent duty applications where space and weight are important considerations.
Lightweight universal motor for portable devices requiring a self-ventilated, high-speed motor.
DEPENDABILITY
IS COMBINED WITH
LOW WEIGHT IN

★ Lamb Electric
SPECIAL APPLICATION FRACTIONAL HORSEPOWER MOTORS

The wide use of Lamb Electric Motors in aircraft components, home appliances, portable electric tools and other portable devices is impressive evidence of the fact that they combine thorough dependability with low weight.

To obtain these and the other advantages of Lamb Electric specially engineered motors, it is important that the motor be considered while the product is still in the design stage.

The Lamb Electric Company Kent, Ohio
In Canada: Lamb Electric — Division of Sangamo Company Ltd.— Leaside, Ontario

THEY'RE POWERING AMERICA'S *Finest* PRODUCTS

Lamb Electric
SPECIAL APPLICATION FRACTIONAL HORSEPOWER MOTORS

ENGINEERS

FOR ATOMIC WEAPONS INSTALLATION

Mechanical Engineers, Electronics and Electrical Engineers, Physicists, Aerodynamicists, and Mathematicians. A variety of positions in research and development open for men with Bachelors or advanced degrees with or without applicable experience.

These are permanent positions with Sandia Corporation, a subsidiary of the Western Electric Company, which operates the Laboratory under contract with the Atomic Energy Commission. The Laboratory offers excellent working conditions and liberal employee benefits, including paid vacations, sickness benefits, group life insurance and a contributory retirement plan.

LOCATE IN THE

Healthful Southwest

Albuquerque, center of a metropolitan area of 150,000, is located in the Rio Grande Valley, one mile above sea level. Albuquerque lies at the foot of the Sandia Mountains which rise to 11,000 feet. Cosmopolitan shopping centers, scenic beauty, historic interest, year 'round sports, and sunny, mild, dry climate make Albuquerque an ideal home. New residents experience little difficulty in obtaining adequate housing in the Albuquerque area

THIS IS NOT A CIVIL SERVICE APPOINTMENT

Make Application to the

PROFESSIONAL EMPLOYMENT DIVISION

SANDIA *Corporation*

SANDIA BASE

ALBUQUERQUE, N. M.

Engineers

AN INVITATION TO YOU TO GO PLACES WITH FAIRCHILD

Robert D. Gilson, Chief of Structures. Has worked on many top aviation projects in the aircraft industry, specializing in structural problems.

A secure future, exceptional opportunities for advancement, and a high starting salary await you at FAIRCHILD. We have openings right now for qualified engineers and designers in all phases of aircraft manufacturing.

Paid vacations, liberal health and life insurance coverage, 5-day, 40-hour week as a base. Premium is paid when longer work week is scheduled.

ENGINE AND AIRPLANE CORPORATION

FAIRCHILD *Aircraft Division*

HAGERSTOWN, MARYLAND

ELECTRONICS ENGINEERS

Project • Design • Group • Field • Junior • Senior

AIRCRAFT ARMAMENTS' development engineering program in the fields of radar, fire control and associated equipment has provided more openings for men at all levels of experience.

If you are considering a change and are looking for a young, growing company with a continuing program of development work, we would appreciate receiving your resume and would welcome the opportunity of providing you with information about our company.

D. J. WISHART
Director of Personnel

AIRCRAFT ARMAMENTS INC.
4415-17 REISTERSTOWN ROAD
BALTIMORE 15, MD.

DESIGNERS AVAILABLE

"CAL-AERO TECH" graduates are immediately useful without break-in...and dependable.

EXPERIENCE

4000 hours on board and in aircraft shops, with fundamentals and actual work assignments under supervision of Aircraft Factory Experienced Designers — specializing in design of component parts — proficient in layout, strength checking and manufacturing process analysis.

***New class graduates each month*— serving Douglas • North American • Boeing • Northrop • Curtiss-Wright • Lockheed Convair • Ryan • Airesearch • and many others.**

HIRE A "CAL-AERO" GRADUATE — HE'LL DELIVER THE GOODS

Phone or write

CAL-AERO TECHNICAL INSTITUTE

Grand Central Air Terminal — Glendale 1, California

Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to Aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

Wanted

Aeronautical Engineer—To teach aeronautical engineering in program of Flight Safety conducted for U.S.A.F. by University of Southern California. Desirable qualifications: B.S. in A.E.; teaching and practical experience in aerodynamics, structures, etc. Salary $7,000–$9,000, depending on qualifications. Address replies to: Dr. Louis Kaplan, Office of Flight Safety, University of Southern California, Los Angeles 7, Calif.

Engineers—Opportunities for employment in the Naval Aviation Program exist in the Bureau of Aeronautics, Department of the Navy, Washington, D.C. Professional engineers with experience in aerodynamics are wanted to fill civil service positions up to and including grade GS-11, $5,940 per annum. A professional engineer with experience in hydrodynamics and in Seaplane Towing Tank work is desired to fill a civil service position, grade GS-11, at $5,940 per annum. Applications may be submitted on Standard Form 57, Application for Federal Employment, to the Department of the Navy, Bureau of Aeronautics, Personnel Division, Attention PE-22, Washington 25, D.C. The Standard Form 57 is available at U.S. Post Offices or may be obtained by writing to the Personnel Division, Bureau of Aeronautics. For additional details and information call or write to the Personnel Division, Bureau of Aeronautics. Visitors to the Washington area may call at Room 3909 of the Main Navy Building, 19th and Constitution Avenue, N.W.

457. Development Engineer—A large Cleveland manufacturer is now adding a jet-engine development laboratory and expanding its automotive engine research and development facilities. There are several openings for aeronautical and automotive engineers whose primary interest is engine development. We are not engine builders, but have been active in the research and development of engine components and accessories. Make your reply complete.

454. Professor—State university located in the East has an opening for a professor to teach internal combustion engines and related courses to mechanical and aeronautical engineering students. Excellent opportunity present to develop strong program in power-plant field. Kindly furnish personal data, educational background, and experience in initial reply.

445. Instructor or Professor—Aeronautical Engineering Department of a large Midwestern university has position open in its teaching staff. Prefers man with Ph.D. degree and experience to teach aircraft structures, design, and related subjects. Salary and rank dependent upon background. Excellent town in which to live. Growing school and department.

444. Landing Gear Engineer—3 to 5 years of design and stress-analysis experience. Knowledge of landing-gear drop testing also helpful. Must be capable of preparing stress reports. Salary commensurate with experience.

443. Aircraft Hydraulic Engineers—Knowledge of Aircraft Hydraulics essential. Acquaintance with military design specifications also helpful. Must have working knowledge of manufacturing and test procedures. Salary commensurate with experience.

Available

455. Aeronautical Engineer and Aviation Executive—Young, aggressive, responsible, full of initiative, with 17 years' experience in the aviation industry. This experience includes 5 years at management level and 12 years of comprehensive engineering assignments. The management experience includes successful handling of sales (instruments and accessories); contract negotiation in specifications and financial; and contacts with all aircraft manufacturers, air lines, U.S.A.F. and BuAero, and some production. Engineering experience was particularly demanding in stress analysis, airplane structural design, testing, aerodynamics, and supervision. This covers participation in eleven complete aircraft projects and approximately 39 others of a preliminary or partial nature as a project engineer, project stress and structural engineer, or senior engineer. Familiar by contact and execution with all departments and divisions of aircraft design, production, procurement, and sales. University graduate, Who's Who in Engineering, Who's Who in Aviation, registered professional engineer, certificated private pilot. Desires interview with responsible companies seeking top-level management personnel to handle engineering, sales engineering, aviation division, or equivalent.

453. Aeronautical Engineer—B.S., M.S. in Aero. Engrg. Nine years' experience in structures aerodynamics, dynamic analysis, and manufacturing. Papers published. At present, project engineer directing dynamic analysis of a missile. Interested in staff or administrative position in missile engineering, level commensurate with salary over $10,000. Detailed professional history given only on receipt of letter describing specific position.

452. Flutter and VibrationEng ineer—B.Ae.E., M.Ae.E. Age 28. Four years of diversified experience in the fields of vibration and flutter including allied instrumentation with one of the largest air-frame manufacturers on the East Coast. Desires stimulating position requiring ingenuity and imagination. Interested in research and development work with progressive concern or a position as senior vibrations engineer in a supervisory capacity. Also interested in becoming a partner or active member in an associated private business venture and willing to invest small sum of money. East Coast location preferred but will relocate if salary is right.

451. Aero-Mechanical Engineer—5 years of college, B.S.E. Two years of junior design and production-design liaison; 6 months hydraulic servos. Former bomber-transport pilot. Desires a responsible position as a development, sales-service, field, or junior project engineer. Prefers a small eastern company. Will consider all inquiries.

449. Engineer—B.S. in M.E., M.E. Offering an outstanding record in design development, sales engineering, and administrative experience for last 13 years. Extensive experience in aircraft structures, light-alloy products design, and reinforced plastics production and design forms technical background. Author of several papers on these subjects. Proved capability of group direction. A wide range of interests aids facility of meeting people easily. Seeking supervisory or administrative position in industry allied with above subjects. Will consider sales engineering territory for large basic-material producing company. Complete résumé upon request. Please indicate nature and salary range of available positions in first letter.

448. Washington Representation—Well-established and competent technical representative desires part-time representation work before Government agencies for one or two additional clients on retainer fee basis. No commission work accepted.

446. Translator—Russian translator interested in part-time work on technical and scientific subject matter in the aeronautical engineering field. Postgraduate engineering degree and 15 years' experience in various phases of air-frame, engine, and equipment manufacture and test. Familiar with current developments and terminology in aircraft and guided missiles.

442. Canadian Engineering Sales Executive—With Dominion-wide personal contacts in aviation and industrial fields; seeks contact with United States company interested in entering or improving organization in Canada. First-class references available. Presently General Sales Manager for Canadian company. Will consider manufacturing or representation for mechanical components, all systems.

441. Engineer—B.S. Aero. Engr. Supervisory experience as assistant chief of laboratory. Experience in the following categories: dimensional inspection including use of vernier-type equipment, supermicrometers, profilometers, comparators, and other high-precision equipment; layout and stress analysis of structural jigs and fixtures: electrical testing including use of multimeters, oscillographs, strain gages, and other electrical equipment; testing for physical properties of metals, plastics, rubber, and cloth including use of various types of tension, compression, and fatigue machines; testing and analysis of corrosion-resistance properties of metals; microexamination of metal structures including use of metallograph, polishing, etching, and molding machines; operation and analysis of magnetic particle testing and static process of inspecting nonmetallic materials; operation of X-ray machine and analysis of radiographs of metal components; photographic work including copying, developing, printing, and photomacrographs; correlated data from various departments and report writing; and assisted in setting standards for classification of metal defects.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

Frankly, working at North American requires hard thinking and plenty of vision. Because North American always works in the future. Yet, if you are interested in advanced thinking, if you'd like to work on the planes that will make tomorrow's aviation history, you'll like working at North American. North American offers these extra benefits, too.

North American Extras—

Salaries commensurate with ability and experience • Paid vacations • A growing organization • Complete employee service program • Cost of living bonuses • Six paid holidays a year • Finest facilities and equipment • Excellent opportunities for advancement • Group insurance including family plan • Paid sick leave • Transportation and moving allowances • Educational refund program • Low cost group health (including family) and accident and life insurance • A company 24 years young.

Write Today

Please write us for complete information on career opportunities at North American. Include a summary of your education, background and experience.

CHECK THESE OPPORTUNITIES AT North American

- Aerodynamicists
- Stress Engineers
- Aircraft Designers and Draftsmen
- Specialists in all fields of aircraft engineering
- Recent engineering graduates
- Engineers with skills adaptable to aircraft engineering
- Electrical and Electronic Engineers

NORTH AMERICAN AVIATION, INC.

Dept. 1, Engineering Personnel Office
Los Angeles International Airport
Los Angeles 45, Calif.; Columbus 16, Ohio

North American Has Built More Airplanes Than Any Other Company In The World

OUTSTANDING ENGINEERING OPPORTUNITY

Are you a specialist or a recent graduate proficient or interested in one or more of the following fields?

- **Aero-thermodynamics**
- **Internal Aerodynamics**
- **External Aerodynamics**
- **Ballistics**
- **Ram Jet and Turbo Jet Test and Performance**
- **Transonic and Supersonic Test Operations**
- **Turbine and Compressor Design**

Sverdrup & Parcel, Inc., is engaged in the design of advanced and unusual aeronautical test facilities which require the theory and application of these special fields. The wide variety of our work, embracing the design of general industrial facilities of all types, offers challenging problems and provides excellent opportunity for individual development and advancement. Starting salary and extent of responsibility are dependent upon individual ability and experience. Fringe benefits include: an unusually attractive Employee Benefit Plan which furnishes insurance features and provides for retirement; paid vacations, holidays and sick leave; overtime rates; and an employees' club which offers interesting social and practical values. Two accredited universities offer opportunity for advanced education.

Your letter of inquiry will receive prompt attention and reply. Please write to—

SVERDRUP & PARCEL, Inc.
Consulting Engineers
915 OLIVE ST. ST. LOUIS 1, MO.

Available Soon

1953

AERONAUTICAL ENGINEERING CATALOG

CONTENTS:

- Complete technical data on hundreds of aircraft parts, materials, accessories and equipment.
- Over 45,000 individual listings to the manufacturers of more than 2,500 aircraft and guided missile parts.
- The names and latest addresses of the principal manufacturers of every type of aircraft and guided missile component now being produced.

Publication Date
March, 1953

INSTITUTE OF THE AERONAUTICAL SCIENCES
2 East 64th St., New York 21, N.Y.